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FRANK A. HILL. 1841–1903

HON. FRANK ALPINE HILL, secretary of the Massachussets State Board of Education, died in Brookline, Mass., on September 12, 1903, at the age of sixty-two.

He was born in Biddeford, Me., was educated in the schools of his native town and at Bowdoin College, and graduated from Bowdoin with the degree of A.B. at the age of twenty. In 1894 Bowdoin conferred on him the degree of Litt.D. He was always an apt pupil, and, besides paying his own college expenses by teaching in the long vacations, he had time to participate actively in the various literary, scientific, and athletic organizations of his college. He was elected a member of the Phi Beta Kappa Society and delivered an oration on Commencement day.

After graduation, he was for a brief period principal of the Limington (Me.) Academy, but soon left this post to become principal of the Biddeford High School, where he remained for three years. In 1864–65 he studied law, but turned again to teaching.

He was successively and without interruption principal of the Milford (Mass.) High School (five years); principal of the Chelsea (Mass.) High School (sixteen years); headmaster of the Cambridge (Mass.) English High School, where, also, he was associated with others in the development of the Rindge Manual Training High School (five years); headmaster of the Boston

Mechanic Arts High School (one year); secretary of the State Board of Education (from May, 1894) until the time of his death.

In all these important posts Dr. Hill showed admirable personal qualities and rare ability as a teacher and executive officer. Every school over which he presided felt the influence of his genial personality, his industry and conscientious devotion to duty, and his high ideals of scholarship; and was carried on in the spirit of helpful co-operation between pupils and teachers. During this period he found time to do some work on school-books, particularly in editing the revised Holmes series of readers, and in helping to render John Fiske's *Civil Government* and *United States History* available for use in schools.

As secretary of the Board of Education he exhibited the same sterling qualities as a man and as an educational officer that marked his earlier career. His annual reports are not only useful and interesting to residents of Massachusetts, but are among the more important contributions to contemporary educational literature. He was a strong influence in securing important school legislation, notably the provisions making admission to the state normal schools dependent on graduation from a good high school or its equivalent; the provisions requiring every town in the state to employ a superintendent of schools, either alone or together with another town or other towns; the laws that bring a high-school education within the reach of every child in the state; and those establishing a scheme for the state examination and certification of teachers. He was a careful, but also a progressive, man, and when convinced of the wisdom of some policy he had conceived, or which had been intrusted to him, he moved quietly but steadily toward its consummation.

Dr. Hill was in constant demand as a public speaker, especially at educational gatherings of all kinds. His public utterances were marked by enthusiasm and sanity. Among his published addresses some have been called for in large numbers from all parts of the country, especially one entitled "How Far is the Public High School a Just Charge on the Public Treasury?" This address has been sent for by the hundred, and

justly, both because it is a good statement of the full significance of the public high school in American life, and also because it is one of the best expositions that the country has produced of the principles on which our public-school system is based.

Dr. Hill held many educational offices during his career in Massachusetts, and also many offices in private life. He was *ex officio* one of the two commissioners of the state school fund (the treasurer of the commonwealth is the other), a trustee of the Boston Museum of Fine Arts, and a trustee of the State Agricultural College. He was a member of the corporation of the Massachusetts Institute of Technology, both *ex officio* and by election. He was appointed a member of the Schools Examination Board of Harvard University when that board was active in 1892–95. He had been president of a number of teachers' associations and clubs, among them the Massachusetts Schoolmasters' Club, over which he presided for two years. He had also been president of the Cambridge Club—an organization of one hundred and fifty of the leading citizens of Cambridge, founded to "promote literary and social culture among its members, and especially to consider and discuss questions relating to the welfare of the city of Cambridge." When he was stricken by his last illness, he was chairman of the Committee of Eleven on the Organization of Contemporary Educational Experience appointed by the Department of Superintendence of the National Educational Association in 1901, but this office his failing health obliged him to resign, much to the regret of his associates on the committee.

Dr. Hill's life was full of activity. Tireless industry and devotion to duty were prominent characteristics of his nature, and marked his private life no less than his public career. He was a good private citizen, an efficient and a very successful teacher and school officer, and he was loved and valued as a friend.

PAUL H. HANUS.

HARVARD UNIVERSITY.

MATHEMATICS AND THE CO-ORDINATION OF MATHEMATICS AND PHYSICS IN SECONDARY SCHOOLS.

THERE is no gainsaying the fact that in New England, at least, the courses of study in secondary schools — and this is especially true in reference to mathematics — are determined largely by the character of the entrance examinations maintained by our leading colleges and scientific schools. This state of things, existing in spite of the fact that only a very small percentage of our boys and girls — figures are dangerous here — ever see the inside of a "higher institution," has arisen in part from the following conditions:

1. The prestige of the college professor in the educational world carries authority with it.

2. Few pupils in a secondary school, whether they really expect to go on or not, like to have the college door swung together in their very faces at this early stage in their educational career, and fewer teachers are willing to assume the responsibility for such action. It follows, therefore, that the course which leads to college must be kept continually in mind by all.

3. Text-books prepared for secondary schools are invariably based upon the college-entrance requirements as interpreted by the aforesaid examinations; for no reliable publisher would dare accept the manuscript of a high-school text that could not be honestly said to cover the ground referred to in the current "requirements," as stated in the catalogues of Harvard, Yale, Dartmouth, and the rest. Witness the lifeless uniformity of the great majority of our elementary text-books both as to subject-matter, order of topics, and method of presentation, as well as the oft-recurring phrase, "designed to cover college requirements."

This being the situation in New England, it will be interesting to look over a few of these college-entrance papers to see if we can discover any important characteristics common to them

all. In Appendix A are found the papers of a dozen of our New England colleges and scientific schools as set for June, 1903. There is evident, at once, a striking uniformity in this, that the problems submitted in algebra are almost without exception of the most abstract character—the factoring of polynominals; the solution of simultaneous quadratic-equations involving x and y; the determination of the coefficient of a given term in an expression to be developed by means of the binominal theorem; the reduction to simple forms of expressions involving fractional and negative exponents; and the summation of series. Rarely a reference to business or to science, or to any feature of daily life. Is it any wonder that our college-preparatory pupils, in their moments of depression, often inquire as to the real use of such a subject as elementary algebra?

A similar condition of things exists in reference to geometry, understood by us all to be the basis of architecture, design, and the various symmetrical forms of nature. The symmetry of the flower, the cell, and the crystal, the proportions of good design, the elements of mechanism, and the salient features of mechanical drawing are made to give way to problems involving incommensurables, limits, extreme and mean ratio, and the computation of π.

The plane trigonometry even presents no hint of a practical application, but runs the weary round of the various transformations occurring in goniometry and the solution of the abstract triangle.

The idea of the examiner appears to be that if the pupil's mathematical tools are in fair condition, it matters not whether he has learned to use them for anything or not.

The various attempts at applied algebra that occasionally appear in these papers are often quite amusing when viewed from the standpoint of daily life. (See Appendix B, 1, 2, 3.)

So much for the nature of the entrance examination—the practical college requirement.

Turning now to the schools themselves, what do we find? Pure mathematics in the saddle: applied mathematics pushed to one side, or neglected altogether. The average pupil upon enter-

ing the high school is able to perform the fundamental operations of arithmetic fairly well, but he has, of course, at this early stage never learned to apply his mathematics to any great extent —especially since so much of mensuration, business arithmetic, and applied problems has been omitted from our grammar-school courses—and he is sadly lacking in logic. He needs training in clearness of thinking and a strengthening of his faith in mathematics as a useful instrument. He usually gets a course in formal algebra, made up largely of "examples"—I use the word advisedly—involving purely abstract quantities, represented generally by x and y, with the addition later of a, b, c, and d, varied occasionally by an applied problem concerning the hands of a watch or the pursuit of a hare by a greyhound. Cross-references to physics, manual training, business affairs, or daily life, or even to the history of mathematics, are almost unknown. The next year comes a course in plane geometry, divorced entirely from any practical application whatever—the dry bones of the subject; a fine training in logic, accurate statement, and keen thinking, I grant, and of inestimable value as such, but lacking the prime essential of practical application. Trigonometry and advanced algebra, treated in a similiar manner, follow.

This state of things cannot last. The unprecedented development of manual training, laboratory methods in science, applied physics based upon mathematics, and our astounding commercial advancement as a nation demand a change. The concrete must go hand in hand with the abstract. "Correlation" must be our watchword. The teachers of mathematics, of natural science, and of manual training must become bosom friends, each vitally interested in and conversant with the work of the other two. Frequent conferences must be held. Points of contact must be eagerly sought after and developed until their number and area are greatly increased. The colleges must help by abridging their requirements in pure mathematics and asking for more applications. In the end, a new subject, known as "every-day mathematics," may be formed by a fusion of physics, manual training, algebra, and geometry; worth infinitely more to the non-college pupil than the present courses can ever be, while form-

ing at the same time a solid basis for subsequent applied work in the college and scientific school.[1]

What will become of the Pure Mathematics, as we know it today, I do not know, but I assume that it will follow the well-known law of the survival of the fittest.

Fusion is in the air. Witness the organization of the Central Association of Science and Mathematics Teachers, with its masterly report of a Committee on the Correlation of Mathematics and Physics in Secondary Schools, to which the writer acknowledges his indebtedness; the formation of the Association of Mathematical Teachers in New England, under the inspiration of Professor Osgood and others; the establishment of an organ, *Supplement to School Science*, devoted to the interests of applied mathematics; and, lastly, the growing sympathy that is manifest everywhere between teachers of pure and applied science. We are on the verge of a new movement. Reforms come slowly. We must not be rash, but each one of us must contribute his share, honestly and fearlessly, in accordance with his best light, to the grand result.

To bring the matter before you, then, not in the form of an ideal course, but as a series of notes in substantial agreement with much of the report referred to, to be discussed and developed, I submit the following points for your consideration:

In our elementary algebra, let us omit or greatly subordinate: (1) H. C. F. by the method of successive division; (2) the factoring of expressions containing two trinomial factors; (3) continued fractions and fractions "many times compounded;" (4) the binomial theorem, except for the square and the cube; (5) cube root; (6) binomial surds; (7) complicated radicals; (8) simultaneous quadratics, excepting those of the simplest character; (9) imaginaries; (10) series; (11) useless puzzles (see Appendix B, 4, 5; Appendix C, 1, 2, 3). Professors D. C. and J. P. Jackson have shown us in their *Elementary Electricity and Magnetism* (Macmillan) how much may be done along practical lines with a very meager mathematical equipment. Let us emphasize

[1] Such a course for beginners may be found in a book entitled *First Course in Mathematics*, published by Doubleday & McClure, New York, N. Y., and edited by SEYMOUR EATON.

the simple equation and its numerous applications—to levers, inclined planes, pulleys, and affairs of daily life; the quadratic as related to the laws of falling bodies and, as far as possible, to the various graphs clustering about the circle—the ellipse, the parabola, and the hyperbola—introducing, in connection with the conic sections, many interesting problems of a simple character concerning centrifugal motion, projectiles, Boyle's law, and planetary motion. Let us teach the practical use of the slide rule, the vernier, and the logarithmic table. Let us make frequent use of formulæ based upon actual data obtained from the laboratory, the workshop, and daily life. These should be manipulated so frequently and so completely that the pupil may come to look upon a formula as a shorthand rule for the solution of a practical problem. The most useful should be memorized and made thoroughly familiar by frequent use and many concrete applications.[1] Let us teach ratio, direct and inverse, as applied to problems in optics, specific gravity, and the like. Let us see that our pupils make frequent use of the graph, discuss its many applications, and carefully consider its interpretations until this form of expression becomes thoroughly familiar. Data for this work can be obtained from railway time-tables, temperature and barometer records as published by the Weather Bureau, observations made in the physical laboratory, and from such books as Haswell's *Mechanic's and Engineer's Pocket-Book*. Let us introduce in great abundance—and much of value can be learned in this connection from the literature of correspondence schools—problems concerning ventilation, heating, and household economics. Our continual aim should be to make the pupil feel that he is getting something that he can use—a new tool.

In geometry, let us agree upon the syllabus published by Harvard University, but rearranged so as to be more nearly in keeping with existing texts. Let us omit limits, incommensurables, and the derivation of π. Let us teach our pupils to treat much of the syllabus as an outline for original demonstration, adding many applications to architecture, mechanical draw-

[1] See SNYDER AND PALMER, *One Thousand Problems in Physics* (Ginn & Co.); PIERCE, *Problems in Elementary Physics* (Henry Holt & Co.).

ing, and physics. Let us display, under the head of "symmetry," a large number of the most beautiful of the geometrical forms of nature, taken from crystallography, botany, and optics, upon the walls of our schoolrooms. Let us review the graph, introduce simple problems from surveying, mechanical drawing, domestic science, and architecture; illustrate mensuration by means of real solids; demonstrate the reality of many theorems by means of squared paper and the balance; review formulæ; use the diagonal scale and the vernier in measurement of lines, and logarithmic tables for computation. Let us teach the nature of errors, and the method of finding the percentage of error. Above all, let us teach constructions as practical men use them. Under parallelograms, let us teach composition and resolution of forces. Under trapezoid, teach simple methods of finding areas. Under construction of triangles with three sides given, let us teach methods of bracing used by bridge-builders and architects; under triangle with one side and two angles given, teach method of locating an inaccessible object, referring by means of a diagram to method of finding the distance to the sun and moon. Under construction of a circle through three points, show shop method of centering. When dealing with the right triangle, let us teach the trigonometric functions, graphically, by means of a simple diagram. The relation of the sides may be illustrated in many ways by paper-folding, and under this head many interesting problems in mechanics may be taken up. Under similar figures, let us teach drawing to scale. Under mensuration of solids, let us review formulæ. Finally the conic sections may be reviewed and a brief introduction to Analytics be made.[1]

Trigonometry should be made intensely practical by use of a simple level and protractor, subordinating goniometry and elevating practice.

Advanced algebra should be reserved for the college.

By way of experiment, the teacher of physics and mathematics might work together, each contributing his share, the recitation being held indifferently in the laboratory, the workshop, or the mathematical recitation room.

[1] T. SUNDARA ROW, *Geometric Exercises in Paper-Folding* (published by Open Court Publishing Co., Chicago); CAMPBELL, *Observational Geometry* (Harper Bros.).

The difficulties in the way of the above reform are many, but they are not insuperable. The college professor will have to give us his opinion as to what can be spared from the present curriculum in preparation for his work, and we shall have to make our substitutions of the concrete and practical for the abstract and theoretical with great care, that we may not mar the symmetry of the pure mathematics, nor emasculate the subject.

To recapitulate:

College-entrance requirements place a premium upon pure mathematics. As a consequence, our secondary schools have taken to emphasizing formal algebra, geometry, and trigonometry to such an extent that cross-references to applied science, and even to the history of mathematics, are almost unknown. The extension of mathematical methods to almost every branch of applied science calls for a change. The sharpening of tools has proceeded far enough. We must begin to acquire skill in their use. Points of contact between physics, manual training, domestic science, and mathematics must be eagerly sought after and developed. The colleges must help by abridging their requirements in pure mathematics and asking for more of the applied. By way of a beginning — not to be too revolutionary — let us omit the least practical portions of the algebra, and add many problems from the departments of applied science, showing clearly the relation between the abstract and the concrete, the theoretical and the practical, let us emphasize the graph and its many applications: expand the subjects of formulæ and ratio, by teaching some of their applications — making use of the physical laboratory in this connection, if need be; let us teach the manipulation of the slide rule, the vernier, caliper, and the logarithmic table; finally let us endeavor constantly to make our pupils feel that algebra is a useful tool as well as an interesting subject for contemplation.

In geometry, let us agree upon the Harvard syllabus, omitting limits, incommensurables, and the derivation of π; let us introduce many problems from architecture, domestic science, mechanical drawing, and physics, making use of the laboratory as far as possible, that the subject may appear more real and the

relation between the abstract and the concrete be more plainly seen; let us make use of squared paper, the diagonal scale, the vernier, and the balance in demonstration of theorems; let us make constant reference to the history of the subject, and thus imbue our pupils with the spirit of some of the old-time heroes of the science; finally, let us strive by every means in our power to impress our pupils with the utility as well as the beauty of the subject; let us treat trigonometry as the handmaid of surveying.

If we do these things, our pupils will at last be able to *do* as well as *see*.

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APPENDIX A.

Papers referred to were those of (1) Amherst; (2) Bowdoin; (3) Brown; (4) Dartmouth; (5) Harvard, including Lawrence Scientific School; (6) Massachusetts Institute of Technology; (7) Sheffield Scientific School; (8) Smith; (9) Wellesley; (10) Wesleyan; (11) Williams; (12) Yale, Out of 271 problems submitted not over 15 could by any stretch of the imagination be counted as "practical." It is to be remembered that Harvard, to her credit be it said, has long required a course in elementary physics, treated largely as a branch of applied mathematics, for entrance to any department of the university, and sets an examination in the same. This subject is treated by itself, however, and there is but very little attempt at anything like a correlation between pure and applied mathematics apparent.

APPENDIX B.

APPLIED ALGEBRA.

(Harvard, since 1898.)

4. A certain trust company pays interest at the rate of 2 per cent. per annum on the whole of any deposit exceeding $300, and no interest on smaller deposits. A certain savings bank pays interest at the rate of 4 per cent. per annum on all deposits. A man has deposits both in the bank and with the trust company. He transfers $150 from the savings bank to the trust company, and his annual income is increased by two dollars. If, instead of $150, he had transferred a certain different amount from the savings bank to the trust company, his annual income would have been decreased by one dollar. Find the second amount.

The federal inheritance tax on an estate of a dollars is r_1 per cent. of the difference between the value of the estate and the state tax. The state tax is r_2 per cent. of the difference between the value of the estate and the federal tax. Find how much each tax is.

A man rowed every day from A to B against the current of a river, then back with the current from B to A. One day after a heavy rain the river was swollen, and the current was more rapid than usual. The man noticed that he made the return trip from B to A with the current in four-fifths of his usual time for the return trip, but that his time for the whole trip, to B and back, was twice the usual time. How much faster was the current than usual?

Two wheelmen, A and B, are riding eastward over the same road, B's eastward rate exceeding A's by four miles an hour. A certain milestone M is passed by A at noon and by B fifteen minutes later; a second milestone N, six miles east of M, is passed by both wheelmen at the same instant. Find the rate of each wheelman in miles per hour, and the time of their passing N.

5. I travel three hundred miles and back; my return journey being an hour and a half longer than my journey out. If the rate of speed on each journey had been increased by ten miles an hour, the return journey would have been only one hour longer than the journey out. Find the rate of speed on each journey in miles per hour.

The towns A and B are situated on a railway, and also on a highroad running parallel to the railway. At a certain hour a carriage leaves A for B, and, at the same hour, a train leaves B. At three o'clock the carriage and the train are together; the train reaches A at half-past three, and the carriage reaches B at half-past seven. Find the hour at which the carriage leaves A and the train leaves B. (*Two answers.*)

3. Two persons, A and B, run a race to go five times round a certain course. When A has gone three laps, B is 150 yards behind him. A then slackens speed and goes at B's rate, while B quickens his rate and goes at A's first rate. A wins by 30 yards. Find the length of the course, and compare the original speeds of A and B.

1. A policeman is chasing a pickpocket. When the policeman is 80 yards behind him, the pickpocket turns up an alley; but, coming to the end, he finds there is no outlet, turns back, and is caught just as he comes out of the alley. If he had discovered that the alley had no outlet when he had run half way up and had then turned back, the policemen would have had to pursue the thief 120 yards beyond the alley before catching him. How long is the alley?

2. A party of friends went on a pleasure excursion, the expense of which they shared equally. If the number of the party had been decreased by seven, and if the total expense had been \$150, the assessment for each person would have been one dollar more than it was; but if the number of the party had been increased by eight, and if the total expense had been \$160, the assessment for each person would have been one dollar less than it was.

Find the number of the party, the assessment for each person, and the total expense of the excursion.

APPENDIX C.

NEEDLESS COMPLICATIONS.

1. Reduce the following expression:

$$\left[\frac{1}{a+\dfrac{1}{b+\dfrac{1}{c}}} \div \frac{1}{a+\dfrac{1}{b}}\right] - \frac{1}{b\,(abc+a+c)},$$

to its simplest form.

2. Prove

$$\frac{x^4+y^4+x^2y^2}{x^3-y^3} \div \frac{x}{x-1}\left\{x-1-\frac{y}{1+\dfrac{1}{x-1}}\right\} = 1+\frac{xy}{(x-y)^2}.$$

3. Solve the equation

$$\frac{\dfrac{c(2c-1)}{c+1}x+3}{x} = x+\frac{(c-1)\,(c-2)}{1+c}$$

Solve the equation

$$\left(1-\frac{1}{x}\right)\left(1-\frac{x}{a}\right)-\frac{1}{a}\left(\frac{x}{a}-\frac{2a^2-3x}{x}\right)=0;$$

finding two values of x.

Reduce the following expression to a single fraction, having the denominator (a^2-b^2):

$$\frac{2ab}{a+b}-\left(\frac{a}{\sqrt{a+b}}-\frac{b}{\sqrt{a-b}}\right)\left(\frac{b}{\sqrt{a+b}}+\frac{a}{\sqrt{a-b}}\right)$$

4. Write the *fifth* term of $(x-y)^{23}$;

of $(b^{\frac{1}{3}}\sqrt[9]{a^3}-a^{\frac{1}{3}}b^{-3})^{33}$.

Find the twenty-first term of $(x-y)^{34}$. Write, in its simplest form, the value of this term, when

$$x=\sqrt{a^{-\frac{1}{3}}b^{-3}} \qquad\qquad y=(a^{\frac{1}{3}}b^{3})^{\frac{1}{2}}.$$

PROFESSOR EDWIN H. HALL: I believe that I suggested this topic for consideration here and suggested Mr. Packard as the one to deal with it. I feel, therefore, that you, having heard the paper, will agree that I have already made an important contribution to the subject,

and I might perhaps, be excused from taking part in the actual debate. In fact, when I was asked to open the discussion, I did beg to be excused, saying that, as the paper was to be from a teacher of physics, I thought the discussion should be opened by a teacher of mathematics, and I suggested one of my colleagues at college who, I hoped, would be willing to discuss the paper. He declined, and I was asked again, and I found that I could not well avoid taking part.

When I consider the matter I find I have very good warrant for taking part in this discussion, for I find that I am a teacher of mathematics, and every one of my assistants is a teacher of mathematics.

One of my assistants in an elementary course came to me two days ago (he is a laboratory assistant) and asked seriously whether he had not better make some extra appointments to meet the class, to show them about arithmetical processes, how to divide, where to put the decimal point, and how to get the area of a circle from the radius. I said: "No, don't do that, because we have another assistant who is appointed for that special purpose."

Now, is there any way of changing this condition of things? I am not very sanguine that we can do much. I should not like to have pupils who have left my hands, my instruction in physics, taken up a year or two later and questioned upon even the simple things that they had had with me, and have my teaching judged by the accuracy of their answers to simple questions, made on the spur of the moment. One of my mathematical colleagues in Harvard says that a mathematician who has had a reasonably long summer vacation cannot integrate the simplest expression when he gets back to college. I think we shall find in the majority of cases that the boy who cannot divide has at some time known how to divide and how to point off, that by disuse or want of practice for a year or two he has forgotten, and that the simplest hint will set him right, and there will, in this particular, be no great difficulty thereafter.

Nevertheless, the difficulty with mathematics is so real in physics, and in elementary physics, that I think we ought to consider whether there is a possibility of getting help from the mathematicians without impairing the work which they are set particularly to do. I think Mr. Packard has done a service to the mathematicians in calling attention to uses which they could make of material given by the physical laboratory. I wish merely to supplement his suggestions and make them a little more concrete in one or two instances.

In one respect I wish to dissent a little from what I understood to

be Mr. Packard's position, although I may have misunderstood him. I think his suggestions go a little too far in one way, in demanding practical applications for immediate use of everything to be taken up. There is danger in that. If we neglect everything that does not have an obvious use, we should not advance so rapidly as the race has advanced. Nothing seemed less likely to be used a decade or two ago than the glow produced in rarefied gases by an electric current. I do not know of anything that twenty years ago seemed more hopeless, from a point of view of use, than investigations in that field of science. But people kept on, and one day the Roentgen rays were discovered. That paid well for the generations of apparently barren work in the investigation of rarefied gases.

Take one specific recommendation of Mr. Packard's. I think that I should not be in a hurry to give pupils the use of logarithm tables, because it is making them dependent upon a certain machine which they will not always have with them. What we want particularly is to have the pupil capable of thinking out his problems.

Now, let me give examples of the kind of problem, or the kind of formula, I have to use continually with my pupils in teaching physics, and which, it seems to me, might well be utilized by teachers of mathematics. Almost any law that can be expressed in the form of an equation — and there are few laws that cannot be so expressed — can be utilized. Let us take this, the principle of Archimedes:

The weight of a body in liquid is equal to the weight in air[1] *minus the weight of displaced liquid.*

If now we let W' stand for the weight in water, V for the volume of the body, D_1 for the density of the body, and D_2 for the density of the liquid, the principle just stated can be expressed thus:

$$W' = VD_1 - VD_2.$$

Here we have an equation with four quantities, W, V, and the two D's, and we can make use of this equation with a great variety of sets of data. For example, this is a problem that I had with a class yesterday.

A certain body weighs W_1 grams in air. A certain vessel weighs W_2 grams when filled with water. When the given body is placed in the given vessel, displacing a part of the water, the weight of the vessel and its contents is W_3. Find the density of the body.

I found that bothered the class considerably. You see, the trouble there is mathematical. There is no question about this simple prin-

[1] Of course, we here neglect the weight of air displaced by the body.

ciple of Archimedes. The difficulty with the problem, as I say, is all an algebraical difficulty — to see how to take the data given and put them into the form of equations which give the required result; and the difficulty is a perfectly respectable difficulty for a beginner in algebra. I think that would be difficult enough, perhaps, for an algebra paper for admission to Harvard. The whole paper, however, need not be made up of such things.

Take the following as another example:

A tube of uniform cross-section 100 cm. long, closed at one end, is plunged, open end downward, into a mercury-well, and is pushed down until just one half its length is submerged. The tube retains all the air which it held before entering the mercury, and the barometric pressure is 76 cm. How far is the final level of the mercury in the tube below the level of the general mercury surface?

The physical principles which apply in this case are:

1. *Boyle's law, pressure and density, for air.*
2. *In a continuous body of liquid at rest pressure is equally great at all points on the same level.*
3. *Pressure at any depth h in a liquid of density D is equal to the pressure at the top of the liquid plus h D.*

Using these principles, in this problem we get a simple quadratic equation with one unknown quantity. The work is quite difficult enough for an elementary algebra course, and is, in fact, rather too mathematical for an elementary course in physics.

Take problems in heat, in calorimetry. We have this general rule: Heat lost equals heat gained; that is, heat lost by the substances which fall in temperature is equal to heat gained by the other substances. When there are several substances to be considered, each with its proper specific heat, and especially when latent heat has to be reckoned with, we get an equation which looks rather formidable to the average pupil.

Ohm's law in electricity is a law the possibilities of which in elementary teaching are not yet exhausted. I have been giving problems on that for ten or twelve years. It is perfectly easy to make variations.

I of course could give more and more of these, but I think I have gone far enough to give samples.

It seems to me that it would be a service to teachers of mathematics and to teachers of physics alike, if someone would make up a list of these useful principles which can be easily expressed in the form of equations.

As to the teaching of mathematics, by itself, I have one suggestion to make concerning what is commonly given as the first proposition in plane geometry. I went through that proposition with a boy a year ago—a reasonably bright boy, not especially quick in mathematics, but one who gets along fairly well. I want to tell you the impression which that proposition made on the boy and the impression it made on me. The demonstration which I have here copied down is from an old geometry, but it is substantially the same as that in the book which the boy was using.

We have here the figure, a straight horizontal line *ACB*, met by another straight line DC in such a way that the two make an obtuse angle *ACD* and an acute angle *DCB*. A perpendicular *CE* is erected from the point C. With this figure we have the following proposition:

If one straight line meet another straight line, the sum of the two adjacent angles would be equal to two right angles.

Now that is, I think, a perfectly self-evident proposition. Any boy who looks at it, with the figure before him, sees that it is true; and when he is asked to *prove* that it is true, he is in this state of mind: Either the person who asks me to do that is an idiot, and I do not know how to reason with him, or I am an idiot.

Now, this is the demonstration as given. Of course, I don't do it quite justice in reading it off here, but still I will read it slowly:

The angle ACD is the sum of the angles ACE and ECD. Therefore ACD plus BCD is the sum of the three angles ACE, ECD and BCD; but the first of these three angles is a right angle, and the other two make up the right angle ECB. Hence the sum of ACD and DCB is equal to two right angles.

By the time the boy has got through that, I think he is in doubt. Of course this can be justified in a way. We know what geometry is. Geometry is a rigid course of reasoning, where you start with certain agreed-upon material, certain agreed-upon axioms and definitions, and you are to use those only. But I think it is unfortunate to apply that machinery to a problem that is self-evident from the very start. The boy ought to use that machinery at the very outset to prove something which he cannot prove without it. This proposition starts a boy with a discouraged, helpless, feeling, which it takes weeks to get over.

MR. WILLIAM A. FRANCIS, of Phillips Exeter Academy.—Fellow-teachers: I can only say "Me too," as the New York politician said. In truth, I agree most heartily with most that has been said, especially what has been said by the first speaker.

Before I forget it, I will explain, to the best of my ability, the reason why that thing is in geometry. I never wrote a geometry, and I hope I never shall, but I will tell you why it is there. A writer of a text-book thinks first of all, not of the boy, or the teacher, but of the critic. The critic who finds that thing lacking would say: "The book is lacking in rigor." And that is the end of it; you cannot sell the book. I believe the definition of an angle can be so written that the theorem may come under that definition and so omit the difficulty which has been mentioned.

I agree, as I said at the beginning, most heartily with the first speaker, but I wish to take issue with him at the very outset on the matter of advanced algebra from the point of view of the practical, which I think he emphasized a little too much. If anywhere, that is the place to use the practical. Advanced algebra does not all consist of the chance of stealing hens. I think it is possible for the first time in a boy's life to make him understand something of the facts with regard to every great business corporation, not with regard to that problem which was read about shifting money from the savings bank to the trust company, but the facts that lie at the foundation of every sinking fund and the facts that lie at the foundation of insurance. If there is anything in our school mathematics that may be made to touch practical life, it is advanced algebra taught in the right way. We are not all to be bankers, but the matter of insurance in all its forms is worth touching upon. If we are going to look at the practical, I think we must not begin by omitting one of the practical things.

I was converted a long while ago to the belief that we teachers of mathematics must try to teach some physics. The first stage of my conversion came about like this, seven or eight years ago. Harvard, having in mind the old problem about truth in the well, gave a problem in trigonometry about the reflection of an object in the bottom of a well. I had a boy who had done fairly good work, but he put that image in an absurd position, away over on the edge of the well, in a place where no human mortal who had ever studied physics would have put it. I said to him, in reasoning with him afterwards: "You studied physics last year, didn't you?" I never saw a farmer who had bought a gold brick, but I think the expression on that boy's face was something like that. A sort of a cold horror came over him. He said: "Why, they would not put a question in physics in a paper in trigonometry, would they?" That opened my eyes that we must make our teaching cover more practical points. I think we are all agreed that

we must make some definite changes in teaching mathematics. I wish to point out a few dangers in regard to making changes too rapidly, too radically, and too hastily.

The first thing I would warn about is the matter of text-books. I have no reference to text-books in inventional geometry, because I admire Mr. Carpenter's text-book, and other inventional geometries; but I mean in regard to the text-books that will appear in the future, if we make these changes. The publishers are enterprising, and they will set men to work at once to produce certain books, and I am afraid, because no man can make a book without trying it on the boys and girls for a number of years. All the secondary-school books that are worth anything have been made in that way. We must beware of plunging into something new. I have heard mentioned twice in this building within a year a sort of composite book, which would teach arithmetic, algebra, geometry, and trigonometry, all in one book. The speaker last evening, I think, suggested it. I hope it will be made; I hope he will make it; but I hope he will not make it until he spends five years in experimental use on boys and girls. I do not know how to make such a book. I hope some of you do, and I hope if you do you will make one.

With regard to these hasty ways that sweep over the country, in mathematical teaching, one of them was one that appeared a few years ago on heuristic geometry. We do not hear so much about that now. The enthusiasts thought they had solved the trouble with the geometry of the secondary schools by making an entirely new invention. I went to visit a school on purpose — in a friendly spirit, to be sure — to see how the thing worked, with one of the most enthusiastic teachers in New England. He claimed it was wrong that the children should take their ideas second-hand — that they should find them all for themselves. I think I state the matter fairly when I say that of a class of eighteen, ten boys and eight girls, there were four boys and two girls doing all the thinking, and the other twelve of the eighteen took their ideas entirely second-hand from the six. I watched the faces of the slower members of the class when a new question arose. They never thought of thinking about the thing, but waited to see what the others thought. I think that is a fair representation of the thing.

It seems to me that, in regard to highest common factor by division, the outcry against it is due to the fact that the problem is made too hard. It is put in a place in the algebra where it tests a boy's ability over the elementary processes — whether he can add, subtract, multiply,

and divide. And another thing, if we wish to bring these different subjects closer together, boys hear the fact that the greatest common divisor and highest common factor and finding the ratio of two commensurable straight lines is exactly the same process. For that purpose alone I should like to keep it, although some institutions, like the Massachusetts Institute of Technology, have hinted that perhaps it would be better to omit it in elementary training. There are other things, like the gymnastics that were given by the first speaker, that I should like to see omitted in the school curriculum. There are some things that we may omit from our geometry too, as maxima and minima and the theory of limits. But there is one thing I should like to plead for here, that is, for the boy who can understand the theory of limits, and there are such boys. I think we should realize in the teaching of secondary schools that we may spoil mathematicians. I spoil some every year. I am sorry for it, but I am sure I do by not giving them enough to do to occupy their minds. Dividing my class roughly, I think about a third of the class understands the theory of limits. I think that third should have the right and chance to study that matter. The other two-thirds are very much like the boy who wrote this in good faith five or six years ago: "Case II, when the arcs are incomprehensible."

There is one word that has been used here a great deal today that I am very much afraid of. It is that word "practical." If we were to point to the subject which is worst taught in the elementary schools, I think all teachers, in mathematics at least, would say it is arithmetic. As the last speaker said, it is unfair to judge a teacher by the work he has done two or three years before, and yet this is my experience in taking up a class in logarithms. I spend several hours in trying, before they begin, to teach them to use a table so that it shall be an instrument to save time and to aid accuracy. In the first written test I say to them: "You write on this page everything which I am to read. On the opposite page put your scribbling work for interpolation, and put just as little as possible on that opposite page." There is a good deal more on the opposite page than on the page I am to read. It is pitiful to find boys within one year of college who dare not trust themselves to get $\frac{6}{16}$ of 13. You say: "Why don't you teach them better?" We try to, and we come to sympathize with the position of the physician of Lady Macbeth.

If there is one thing that the school should enable the boy to do, it is to multiply numbers no harder than 7 times 16 and have confi-

dence that he is likely to be right sometimes. If the rest of you have had a different experience from that, it is because your boys are drawn from parts of the country, perhaps, in which the teaching is good. I get boys from every state in the Union, and it is pitiful to see their struggles with a table of logarithms. I have had four hours of it this week, so you will pardon my reference to my suffering.

In making substitution for the geometry which we teach now, I have no agreement with the gentleman who spoke last evening, that there is very little educational value in demonstrational geometry, and I feel sure that most of you teachers in geometry have not. We must bear in mind this thing, that when we substitute various things, like mechanical drawing and so on, for that kind of geometry, we substitute a thing which is by no means equal in the present stages of the work. It may be equal one of these days, but it is not now. Some of the most hopeless boys I have in geometry are boys who have had two years, perhaps, in mechanical drawing in various schools, and have done the drawing well, but it has given them no idea of geometrical forms.

The first speaker said—and I agree with him—that the colleges must help us. And there is still a great chance for them to help us in one matter that has not been mentioned today, I think. I know that the Harvard papers have been improved very much in elementary mathematics since that problem, when A rode north at six miles an hour and B rode south at a fixed rate—I don't remember the rest of it. It is only a few years ago we were asked to prove that two lines which were perpendicular were parallel, and we were asked to discuss a spherical triangle, which was not a spherical triangle in the ordinary sense in which we use the term. I feel that examination papers are not carefully made with a view to considering the effects upon the boy.

I have one grievance in mind, and that is the September paper of this year in advanced algebra for Harvard College. Time given, one hour. The first question was a question in continued fractions; the second, an arithmetical progression; the third, a question in chance; the fourth, a double question in determinants; the fifth, two questions on the theory of equations; the sixth, a question to approximate a root to three decimal places. That paper represents what happened when they added to our work the teaching of determinants. Just 20 per cent. was added to the difficulty of the paper, and not one minute more of time given.

I spend a great deal of my time in June, when life is a burden and

digestion fails, in putting the boys through a training just exactly like the football training, in order to teach a boy not to run, but to sprint, that he may do more in an hour than he ought to try to do. It is useless to say to the boy: "They do not expect you do six questions, but five." The boy never lives up to that idea. He does two questions, and he sees a half-hour is gone, and then he works in a way that no human being can use and do good work. His work is hurried, often unreasonable, and sometimes entirely senseless. The reason is that in a paper like that he is asked to do in one hour work for which most colleges in a like course give an hour and a half. We could do a great deal more effective work in fitting our boys for the examination if we were not obliged to put them through those gymnastics just simply to make speed.

It is well enough to review. We must review. A boy who knows the quadratic equation does not know it three months from today if he has not used it.

It is natural that teachers of mathematics are dissatisfied with their work; we ought to be. I hope we are all going to try along those lines laid out by the first speaker to make some improvements. The first place to begin is in the work of inventional geometry. The new suggestion, to combine physics and mathematics so as to use effectively the problem that will appeal to the student, is a thing we can all take to heart, but we must be on our guard all the time to remember that when we substitute mere manual training for logical thinking, we are putting in something which is easier, and which can by no means entirely replace the other; and we must remember that, while algebra and geometry which we teach will pass, the habit of thinking straight, which most of our boys and girls may attain, may possibly remain.

THE RELATION OF THE SCHOOL AND COLLEGE TO PUBLIC HEALTH.

PUBLIC health is a broad subject, and in this paper I wish to consider only one phase of it, the health of the individual. I wish it understood in the beginning that I speak on this subject as the most ignorant of laymen. I have no knowledge of the subject except that gained by considerable observation extending over years. Furthermore, I have no settled convictions on the subject. I am convinced that more regard should be given to making a healthy race. Whether that involves the further action of school and college is to be proved.

I suggested this topic for the consideration of this association for the express purpose, not of inflicting my own opinions upon it, but in the hope of finding out just what is needed to make for the righteousness of health, and how far, if at all, we pedagogues are responsible for the health of this and future generations.

In this day it needs no argument to show that there should be a better physical development of humanity. Of course, we know that the general average health is better in our generation than in the past. Vital statistics show that we are stronger, larger, and longer-lived than our forefathers. Even the college woman has disappointed many people. She is larger, more rosy, less nervous, than her seminary and boarding-school predecessor. The average college girl is beautiful, not with the beauty of youth simply, but with the beauty of physical vigor. Nevertheless, people of our day are not as strong as they ought to be. No witness of a commencement exercise, in even the best of our schools and colleges, can look at the faculty and students and say: "Here we have symmetrical education; here the whole man is trained; here the fullness of life is realized, and the joy of life and work is understood." Too often we see the dull eye, the stooping shoulders, the shambling gait, or the overbright eye and flush which show the lack of physical stamina. It is too few, after all, among instructors or instructed who attract us by the

evidence of physical as well as mental alertness. The time is gone when we admire, and even envy, the scholar's stoop, but the time seems not to have come when we fully recognize the necessity of the sound body for the sound mind. We still hear physicians, even, say: "Oh, but think of the great work which delicate people have done. The work of the world has been done by feeble folk." True, but is that any reason why it should be done in future by feeble folk? Is that any proof that those delicate people might not have done even better had they possessed strong bodies? Have they not wasted their own and others' strength, which might have been used to better purpose if they could have been unhampered by the weak body?

In these last few years we are having a revival of interest in physical training which is encouraging, but I question if it does not need direction and if it goes far enough. There is some evidence that, while out-of-door sports and athletics, physical culture and gymnasium work, are invaluable, they are not all that is necessary. We want all this; for life today, by virtue of being so largely a city life, is artificial, and we are forced to take the exercise consciously, which used to come in the day's work. But exercise is not enough. We need to see that the body is not only well exercised, but also well fed and well rested, if we wish to secure genuine vitality and real health.

In talking with parents and in looking over the list of my acquaintances I am dismayed at the number of people who seem satisfied with being not ill. The only self-help most people seem willing to undertake seems to be to "go on a diet," which suggests that maybe the secret of good health lies in the kitchen and not in the office of the physician, the gymnasium, or our province at all. That is what we ought to determine before many years, it would appear.

In these days of rapid transit, when, as someone has said, we need to pray, not "Give us this day our daily bread," but "our daily agility;" in these days when we are demanding the greatest efficiency of machinery, of animals, and of day laborers, we scarcely can demand less than the greatest efficiency for our educated classes. How far are the schools and colleges responsible

for such efficiency? President Eliot has arraigned the public schools for their partial failure. This failure may be, in part, due to the fact that the schools have not attended properly to the whole man. May it not be that, in failing to make for the righteousness of health, we educators have failed in half our work? Are the schools failing to do their part in producing a finer, saner population? This is a question which such an organization as this should consider, not for one day only, but for many. If we are responsible in any part for the physical well-being of the community, we ought to decide, as soon as may be, how far we are responsible, and how we can best meet that responsibility. As teachers we ought to have some ideas as to the physical training of our students. If the schools are to do this work (and they have assumed a part of it), certainly we ought to consider our relation to it as a whole, and not leave the subject to the teachers of physical training alone, any more than we leave the teaching of mathematics or chemistry or history to the specialists alone. We consult the specialists in the mental training, but we also look at each branch in its relation to all the others. Just so, I think, we should do with physical education. If we admit it at all to the schools, we should consider its relation to the whole educational system.

Before this paper was thought of a committee, of which I happened to be chairman, had prepared a series of questions to be sent to colleges, universities, and preparatory schools, asking as to the advisability and practicability of making physical requirements for college entrance and graduation, and as to the attention paid to physical education in both college and school. From the replies it is evident that most educators think some attention should be given to physical education. Many answers indicate a belief that much more attention should be given to this side of education, but some add, in an "end-it-all" way, that it is impossible to do so, as few schools are equipped for good work. We have not considered lack of equipment any reason for giving up the teaching of history or mathematics, or any other study; we have set to work to get the equipment. If this sort of study is necessary, and is ours to give, we must set to

work to give it. Some of the replies indicate the feeling that this is a subject outside the realm of school, by stating that it does not seem wise in this matter to stand *in loco parentis*. Or the statement is made that this is a matter which should be left to the family physician. Perhaps this is true, but it is the opinion of so few that I have been increasingly glad this association was to consider the problem.

The question of the need of the school to stand in the place of the parent has been raised in regard to every movement in education. Once it was questioned whether education of any sort was not best given by the home. Manual training met the same question: "Ought not the home to give this instruction?" Both these questions have been answered in the negative. That is no proof that this question may be so answered; neither is it a proof that it is rightly answered in that way. I agree that the schools do not leave enough for the parents in this day; or, should we put it that the parents leave too much to the school? But that again is no proof that the schools should not take up this branch of work.

If parents are better able, or more willing, to train the children's bodies than their minds; or if children are more capable of training themselves; or if they need less training physically—which is to say—if nature does more for the body than the brain—then we may safely leave this side of education to the home. But there is little promise in this outlook. Neither nature nor the home alone seems equal to the difficulties of modern life. The long walk to school in the bright sunshine and fresh air is no longer possible for the majority of children. The close contact with the soil which country roads afford, the healthy exercise at woodpile and in the big airy kitchen, are not possible in this day of flats and tenements. Nature cannot do her part to vivify and heal and it is correspondingly difficult for parents to do theirs. It is almost impossible for the most intelligent and sensible of mothers to train her children properly in the present state of public sentiment.

This is especially hard for mothers of girls. Educational demands have increased without diminishing social demands.

Time was when a girl was trained only for society, the home; when at school all her studies went to fit her entirely for society. We still demand more socially from women and girls than from men and boys, and as much, if not more, in the line of study. Most girls have some music, if not painting, outside of school. They must receive and make calls as well as attend parties. In the present state of public sentiment a mother does not feel justified in refusing to give her daughters all these opportunities. The result is lack of time for sleep, and, since her exercise is different from that of a boy, she eats less than a boy. In these days, even though it is fashionable to have brown face and hands, big feet, and to play basket-ball, we still find girls coming up to college anæmic, underfed, and under-slept. We still find many girls and boys who have a hot meal only on Saturdays and Sundays during the school year, beeause the family dines at noon before school is out. When I find a girl worn out on entering college, because "she had to sit up late to study every night last winter" the mother pathetically saying—it being easy to see the girl sat up, because she went to one or more parties a week, or was not well enough fed to be able to use her mind properly; when colleges for women have to require seniors to be out of doors a certain number of hours a week—when I see all this obvious disregard for the ordinary laws of health, then, I fear, something radical must be done to create a proper regard for the body.

In this part of the country at least we have given up the contention that mothers can teach all that needs to be known about cooking. There are reasons for thinking that those who cannot teach cooking may not know what ought to be cooked. Do not mistake me; I would not turn our schools into boarding houses; but can we not in some way through the school more directly help the mothers to attend to the diet and general care of their children? Ought we not to do so?

In some way or other we must educate public sentiment to a true valuation of the essentials of life. It is already conceded in some cities that the care of the eyes and ears of children cannot be safely left to the parents or to the family physician;

unless, indeed, there be no family physician, or there being one, he is the kind who cures ills, but thinks it not his office to maintain vigor. Is there any less need to care for the lungs and liver? Or are gymnasium practice and athletics doing the work for those organs? This is what we ought to decide for ourselves as professional educators. Our schools have, to an extent, committed themselves to the practice of attending to the bodies of the youth. Have we gone too far or not far enough? If the school is responsible at all for the bodies of its pupils, is it as responsible for them as for the minds of its pupils? If so, how? And if the school is involved, does that involve the college, or is the college involved regardless of the school?

We all know that most of the reforms in education have come from the top, from the higher rather than the lower schools. If the work in physical education does belong to the schools, it may be that they would sooner get at their work if they have the help and inspiration of the colleges. It may be that the college owes it to the community to take its stand for the beauty of wholeness—for wholeness of body as of mind.

If we grant that the demand of the colleges has been effective in raising the standard of education throughout the country, there is no reason to suppose that their demand for higher physical development would be less effective. There is reason to suppose that, if the colleges stood for the largest measure of physical perfection, the standard of living would be raised to a higher plane.

There is no doubt that a large part of the physical ill-health of a community, of the lack of physical stamina, is the result of an improper valuation of health. Is there any way in which a youth could better be taught the value of good health than by finding lack of it a bar to entrance to college? Mothers would not be so ready to leave the question of food to an ignorant helper, or the regulation of hours of sleep to their children themselves, if they realized that even entrance to college could be secured only by those in good health. We are pretty well agreed that some sort of mental requirement is necessary before admitting a student to college. May it not be just as advisable and

just as expedient to make a physical test as a mental test of ability to do college work?

There are, I take it, three chief reasons for our present college-entrance requirements: (1) to save candidate and college the time of the "weeding-out process;" (2) to insure the right type of college work; (3) to secure the uplift of education in general. Of the last I have already spoken. I wish now to consider whether time would not be saved in this "weeding-out process" if we had a physical requirement as well. I have not known so much about boys in the last few years, but I do know that a considerable number of girls come to college tired out. A girl of that sort does one of several things. She either goes home after a term, or mayhap less, ill, when, if she had not tried to do work for which she was not physically fit, she might have escaped the illness; or she stays in college, drops a part of her work which she worries over for the next few years; or she drags through the year acquiring habits of laziness which stay by her the rest of her college life; or she gets the habit of working for credits and credits alone, with no joy in her work; or she settles into a dig, losing the fun and friendship which make half the value of a college course. In either case she loses the zest of life which should be the birthright of every educated person at least.

Failure of the colleges to send out better-equipped citizens may be, in part, due to the fact that we allow college work to sap the already weakened vitality of so many students. Are not the colleges helping to rob some students of the possession of true culture, not by undue demands upon their time and minds, but by presupposing a sound body? I hold that the present requirements of freshmen and for freshmen are not beyond the ability of the average boy or girl who has a properly trained mind and body. There is some reason to believe the present complaint is the result, not of the undue demands of colleges, but of unnecessary lack of physical strength of the candidates. At least the colleges have no difficulty in getting many students on the present requirement who are healthy. The comparatively small number of unhealthy applicants only emphasizes the use-

lessness of such lack of health. The very fact that the majority of students, even those who enter in poor health, improve even in the first year shows how easily it may be secured. If by demanding that health for entrance we could economize time for student and college alike, and at the same time fulfil the still more important office of teaching the general public the value of health, the college would discharge one more service to society.

The second reason for college entrance requirements is to maintain the type of college work, to keep up the standard of work. Not infrequently, I fancy, every college turns away would-be students who are undoubtedly fitted to benefit in very large measure by the college course—turns away those whose whole lives would be broadened and lightened by four years in college—because they are not prepared to take the course according to the accepted standard of preparation. In such cases it is hard, may be unfair, for this individual, but it is best for the college community, not because this one would keep the class back—she would not—but because it is better in the long run to sacrifice the individual for the sake of keeping up the standard, the college being for society, not for the individual.

Why should it seem more unkind to exclude the physically unprepared than the mentally unprepared? I am not saying what degree of weakness should be barred. I am by no means advocating the imitation of the West Point or Annapolis requirements; those are special schools. I wish only to raise the question whether it would be fair to make a physical requirement. Personally I doubt if the requirement of a reasonable standard of health would be more difficult for students to attain than a mental requirement. I doubt if a reasonable standard of health would keep proportionately more people out of college (after a year or two) than are now kept out by our mental requirements.

It does not seem to me harder to refuse those who are physically unfit than those who are mentally unfit, albeit it is harder to decide in the one case than in the other. But are we to leave the matter simply because the problem is difficult? The question ought to come to us in this way: Is it as harmful to students to live and work side by side with those who are physi-

cally weak as to live and work side by side with those who are mentally weak? Here I mean not weak-minded, but with less development, as I mean with less physical development. Is the gait of a class shortened by the presence of physical weakness, as it is by the presence of mental weakness? Is the buoyancy of the class lessened? Is the moral tone lowered by the one defect more than by the other? If so, we are not only being uneconomic in putting our time and money into one who cannot use it well, but we are immoral in thus preventing the majority from getting all their due.

But regardless of the individual or of college standards, is it good economy for the college as a college to disregard the physical condition of its students so largely? From a purely commercial standpoint, has a college a right to expend its patrimony in educating those who are physically unfit—those, I mean, not in a physical condition to make the most of their opportunities for education?

Our colleges and universities are either endowed by private munificence or supported by tax on the people of a state. No college student begins to pay the expense of his education. In either case the faculty is, as much as the trustees, responsible for the expenditure of the money; at any rate, where the faculty determines the requirements for admission, as most faculties do. That is, the faculty of a college practically invests thousands of dollars of other people's money every year. Are we not, then, just as much under obligation to see that money wisely invested as if we were devoting it to industry? Are we as careful to see that money invested in a man or woman is as carefully invested as the manager of a factory is to see that the money he has is wisely invested in a machine? Of course, we cannot run a college on the basis of a factory, but that does not mean that we are not to be as conscientious in the expenditure as we would be if we were running a factory. The principle is the same whether the return is in watches or men. We do not spend a thousand dollars to make a hundred-dollar watch, and there is no reason why we should spend a thousand dollars to make a hundred-dollar man. That is, however, just what we are accused of doing,

mayhap truly. It is, of course, easier to tell whether a watch will turn out a dollar or a hundred-dollar watch than to tell whether a man will turn out a thousand-dollar man, and the watch has no claim on us to be tried. Our testing of a man in the making cannot be so accurate as testing the gold for a watch; still that does not absolve us from the necessity of making as perfect tests as possible. Honesty in the expenditure of other people's money does demand that we, so far as in us lies, apply all the possible tests to the man, as the assayer applies all the tests in selecting the gold for a watch. I am not saying what those tests should be for us, but simply asking whether we realize all of our responsibilities.

One other commercial view should be considered. Our stores and factories are demanding well-proportioned, healthy workers. It would seem that our schools could demand no less. Factories and railroads, I understand, are refusing to employ men whose fingers show the yellow stain of the habitual cigarette smoker, deeming such too enfeebled in mind and body to be of service; yet our colleges are taking no account of yellow fingers, and make little attempt to teach the morality or economy of vigorous health. Our æsthetic sense has grown until we demand even in our maid servants and men servants a degree of comeliness which good health alone can give. Ought the schools and colleges to demand less? Can they demand less if they are to supply the world with its thinkers and workers?

These are the two questions I would propose for the consideration of this association: (1) Does it rest with the schools to educate the body as well as the mind? (2) Does the present system of inspection and gymnasium work adopted by some schools constitute physical education?

ANNAH MAY SOULE.

MOUNT HOLYOKE COLLEGE.

INFLUENTIAL FALLACIES ABOUT EDUCATION.

THE field of education is fruitful ground for all sorts of opinions. Its soil seems to contain elements that produce abundant crops to reward both optimistic and pessimistic husbandry. The teacher's art, like every other art that seeks to ally itself with the processes of nature—like the art of healing, for example—must always stand in a somewhat equivocal or uncertain position, because we can seldom be quite sure whether any given result or outcome is due to the operation of natural laws or to our interference with their operation. The teacher, therefore, stands on much the same footing as the physician, and there will always be two ways of looking at their practice and estimating its value. And when it comes to a logical and satisfactory defense of any of their methods that may be called in question, both are somewhat lame, for the reason that neither can demonstrate beyond all cavil that the sequences in any particular case are or are not consequences. Too many unseen causes are at work. This exposes our art to continual distrust and misjudgment, from without and from within. The strong current, the almost irresistible suction, the logical maelstrom of the ever-to-be-dreaded *post hoc, ergo propter hoc*, especially when reinforced by the bias of expectancy or strong desire, renders it well-nigh impossible to disentangle a complex result and trace its separate threads back to their true causes. Thus the extreme difficulty of demonstration is apt to throw most of our discussions of educational matters back upon opinions and impressions. Not that these are always despicable; but whatever their value, they are often the best we can get — that is, unless we resort, individually, to the cheap infallibility of sheer self-conceit. For one, I do not mind confessing to a great respect for opinions, and perhaps a still greater respect for what are often stigmatized as "mere impressions." Where conclusive proof is impossible — and it is impossible oftener than we like to confess — what better can we do than sift and weigh opinions, one against another? For illustration, take the statement of John Locke, where he says squarely: "I think I may say that of all the men we meet with, nine parts of ten are what they are, good or evil, useful or not, by their education. 'Tis that which makes the great difference in mankind." Compare with this the equally confident conclusion of Dr. Donaldson, who represents, I suppose, the views of most neurologists of the present day, that "nurture is to be

considered of much less importance than nature;" and "the capacities that we most admire in persons worthy of remark are certainly inborn rather than made." Which of these dictums shall we regard as sound and which as fallacious? Or may both be accepted as containing valuable truth, in view of the enormous range and complexity of human nature? Not that I mean to intimate that one opinion is as good as another — unless with the Irishman's addition, "and a good deal better." Perhaps I should myself incline to the view that, speaking broadly, the transforming power of such education as institutions afford is rather a matter of faith than of sight. But if you were to demand my reasons, I might be glad to beat a retreat.

> "Mazeppa said, 'twere long to tell,
> And we have many a league to go.'"

I think it amounts to a fallacy (and a good big one) to believe, or at least assume, as so many of us do, that what we teach, in the bodily presence of a pupil, he of course learns; and that what a pupil has learned he of course knows. Some such assumption underlies all our discussions of education; it is our major premise. But the view of the learning mind, as static or passive, which is thus implied seems to me not merely "innocent," but puerile in its simplicity. The youthful intellect — the intellect merely, to say nothing of feeling or will, or of the unmapped and undiscovered regions of the soul — is not a tight-bottomed receptacle, not a tub or hopper; it is more a grasshopper, a living thing, a "dainty Ariel," erratic in its movements, proceeding *per saltum*, in unlooked-for directions, often under ground like the ghost in *Hamlet*. Richter shows deeper insight when he likens the teacher's art to that of the fresco painter, who lays his colors on the wet plaster, which seem to fade completely away and which he must ever renew. Our instruction and our examinations take for granted a power of attention that no human mind possesses, and an equally impossible power of retention and expression. They appear to me not to be addressed to human intelligence at all, but to some machine; and yet I hasten to confess my utter inability to offer any substitute, unless on the principle of ceasing to do evil, whether we can presently learn to do well or not. Such an experiment might be worth trying. But to devise or adapt a test comprehensive and searching enough to accomplish what our academic and civil-service examinations attempt — satisfactory as these seem to be to thousands of our craft — is something that awaits a psychological insight and skill that have not yet been vouchsafed to any educator known to me.

Our faith in the potency of instruction — which exceeds any faith ever found in Israel — blinds us to results that plainly indicate a large, a prodigious percentage of failure. Because eminent or successful men generally received some sort of education in the schools, we jump to the conclusion that school training cannot fail to affect in a considerable degree all who are exposed to it. If the effect which we think schooling ought to produce is not apparent, we fondly trust that it is latent and will some day emerge. For many years I have had to deal almost exclusively with high-school graduates, with a few college graduates sprinkled in, and I should be afraid to say how large a proportion I have found who, so far as I could discern, were almost wholly untouched by any influence which could be traced to the instruction they had received. In English literature, for example, they had read, say, a play or two of Shakespeare's, a poem of Milton's, a novel of Scott's, an essay of Carlyle's, etc., interpreted by scholarly editors and skilful teachers; and indeed some shreds, some *disjecta membra*, of all this could generally be discovered clinging feebly to the memory; but of mental tissue formed by any assimilation of these masterpieces, not so much as a trace. I hope we shall some day recognize the fact, and act upon it, that the higher intellectual culture is as far above the reach of ordinary capacities — that is, the capacities of at least nine-tenths of those who now pass some years in school — as are any of the fine arts, and shall no more expect the fruits or even the buds of scholarship because a boy or girl has been exposed to high-school or college opportunities, than we should expect them to be painters or sculptors because they had frequented the art galleries of Europe. Real education I regard as a specialty, demanding quite exceptional gifts or aptitudes, as much so as music, or eloquence, or poetry, or an ascetic life; and I believe it ought not to be pursued, or even entered upon, without a severe novitiate or term of probation. It is my conviction that not more than one in ten, if so many, of the pupils in our high schools today should be encouraged to take time to complete a four-year course there, much less to think of going to college. But in our purblind ambition we do not, and will not, discriminate. We hate discrimination. We are fatally bent on making all alike. We do not nowadays consign the hindmost to the diabolical custody that we used to; we have found a more excellent way — it is to abolish the hindmost altogether. In the modern lexicon of youth — the "teacher's edition" — there is no such word as "hindmost." Now, this is not aiming at the sun; it is shooting your arrow wildly into the zenith, to fall sooner or

later upon your own head. Do not misunderstand me here: I go as much as anybody for the "open door" in education, but I do not believe in dismembering all outsiders in the struggle to pull them in.

There is another fallacy of magnitude, closely related to the preceding, which I think vitiates much of our formal education in these latter days, growing out of the old principle or maxim that the young should be taught those things which they will have to practice when they grow up. The obvious soundness and applicability of this, under certain conditions and within certain limits, gives to the ordinary mind such an assurance of being on the right track as to beget the notion that so safe a principle cannot be carried too far; and so it has come to pass that educators, who ought to know better, are found joining hands with narrow-minded tradespeople and directors of industry in a widespread movement to transform our schools into shops, market gardens, miniature manufactories, and even kitchens. I have seen—I think it was in an abnormal school—young women sawing and planing deal boards to make boxes, and young men beside them, in white aprons, mixing and kneading dough! I could not help thinking that dough was not the only thing mixed, nor the only thing needed, in that school. A year or two ago an association of teachers in one of the large communities of the commonwealth of Massachusetts addressed a circular of inquiry to a number of successful business men in their vicinity, begging for criticisms and suggestions for the improvement of our elementary instruction and training. With two or three exceptions, the replies received called as with one voice for such educational regimen in our schools, *and such only*, as would fit boys and girls to become docile and useful helpers in stores, machine-shops, factories, and offices. With the exceptions just mentioned, not a single man rose above the commonplace utilities that would assist him in making money by the hands of other people. Nor is it my present purpose to hold this class of the community up for scorn; their view of the capacity and destiny of the rising generation, *taken as a whole*, may be nearer right than the teacher's view. But the teacher's function, as I am contending, should lie in a higher plane; and it is the acceptance of such materialistic and ignoble ideals by those who control and administer our educational agencies, the easy and short-sighted yielding to the demands of industrialism and commercialism and athleticism and militarism, with the justification or excuse that these chiefly are what our youth will practice when they become men and women—this, to my mind, is one of the most dangerous fallacies that threaten the future of our public education.

Are we not too much in love with our civilization? Or, rather, are we not too fond of applying the term "civilization" to about every thing we do? You know it is said of Wordsworth that, having decided that he was a poet (as he had abundant reason to do), and knowing that it is the function of the poet to write poetry, he easily adopted the conclusion that whatever he chose to write *was* poetry. So our word "civilization" is so fine and mouth-filling as often to mislead us into fancying that every phase of our national life, every popular pursuit, every new theory or invention, every wave of fashion, is part of our wonderful civilization, and has, in the common phrase, "come to stay!" The ideal which by exaggeration is thus carrying us out to sea takes life in too gross a sense; it swallows it whole. It substitutes the dilute and trivial experiences of everyday existence for the "sound wisdom and discretion" which is the fifth essence of experience distilled from the ages.

Now, it seems to me that by the operation of this fallacy our system and practice of education, throughout its whole extent from kindergarten to university, is becoming enormously distended, not only, as I have said, by the inclusion of a vast number of persons who are not in any high sense educable, but also by the admission of a great excess of subjects and methods, many of which, perhaps most of which, would be better learned wholly outside of school by such as might have special occasion or taste or aptitude for them; and that as a consequence, our teaching is vitiated and diffused and weakened in aim and effect by the mass of ordinary and commonplace instruction and training thus unloaded upon it. It therefore fails, in a great degree, to address itself with point and force to the best capacities and qualities of our best youth. It is not winnowed and select. Its emphasis is on the practical and the practicable. It breeds in-and-in by exalting its own practices into ideals. It takes *itself* for its standard and exemplar. It forgets, or does not care to learn, the noble sentiment expressed by the poet Daniel:

> Unless above himself he can
> Erect himself, how poor a thing is man!

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THE UNIFICATION OF MATHEMATICS IN THE SCHOOL CURRICULUM.

At present mathematics occupies an unenviable place in the curriculum; on the one hand, the majority of pupils dislike it probably more than any other subject, and on the other hand, experts in pedagogy seem to have come to a substantial agreement that it is not suited to the abilities of children who are just beginning their school life. The general opinion seems to be that there are difficulties inherent in the subject that prevent the majority of children from deriving anything like the immediate advantage from the study of it that they do from the study of other subjects. Psychologists tell us that the mathematical faculty is developed comparatively late. I believe that these views are all wrong. In the first place, the lives of the great mathematicians show that a true genius for mathematics almost always makes itself evident very early; in fact, earlier than any other intellectual faculty (Gauss discovered an error in his father's accounts when he was three years old); but, of course, the education of geniuses is not the main object of the schools. In the second place, I believe that the want of effectiveness of mathematical studies is chiefly due to a bad arrangement of the curriculum and to false notions concerning the immediate objects of such studies—perhaps to the absence of any immediate object. With a proper arrangement of the work, mathematics ought to be as effective and as immediately useful as any subject taught in the schools. On numerous and various occasions during the last ten years I have advocated the unification of the elementary mathematics, and I gladly take this opportunity to explain what I understand by such unification.

It is not always immaterial in what form a question is discussed, and this is particularly true of the matter in hand. The reformation of the mathematical curriculum of the secondary schools alone will not answer our purpose; we must simultaneously reform that of the lower grades, upon which that of the higher schools

must be based. Therefore I shall consider the ground that ought to be covered, as it seems to me, in the primary, grammar, and secondary schools together. I believe that all instruction, to be effective, must have an immediate object—an object attainable by practically every pupil to whom it is given; mathematics has no place in a liberal education unless it is taught with such an object. It seems to me that, in a certain sense, the schools are trying to do too much in teaching many things that are purely technical, on the one hand, and many that are adapted only to pupils of distinctly mathematical tastes, on the other hand. I suppose I shall shock many of you by saying that it is my very decided opinion that the study of Euclid, otherwise "elementary" geometry—I prefer to call it "demonstrational" geometry—is, as such, a waste of time for all but a very small proportion of those who are now required to pursue it; not that I would omit it altogether, as you will see later, but that it should be made subordinate to a more useful kind of geometry, which may be called "observational" geometry, the geometry of fact. There was a time when the so-called geometrical method was the standard scientific method of treatment for all mathematical problems; but that time has passed, and the spirit of modern mathematics is, not geometry, but algebra, or, to go back to the first principles, arithmetic. Euclid is, to be sure, one of the mathematical classics, but, as a system of methods, it is, like many other classics, archaic. You will probably more nearly agree with me in the belief that mercantile arithmetic should be reduced to a minimum and regarded only as a series of applications of general principles in the schools of liberal learning, to be mastered more thoroughly, if needed for practical purposes, in the commercial college or the world of business, as any other kind of professional technique is acquired.

Mathematics is often distinguished from the natural sciences by calling it the deductive science, while they are called sciences of observation; in reality, mathematics is itself a science of observation—its concepts are the immediate products of observation, from which also its fundamental principles have been derived by induction. The great difference between it and the other sciences

is that in it induction has already led to a sufficiently complete system of fundamental principles to admit of systematic deduction from them, whereas the other sciences (physics and astronomy to a much less degree than the rest) are still in the rudimentary stage in which the processes of observation and induction have not yet been carried so far as to make deduction possible to any great extent. In this sense alone is mathematics different in its nature from the other sciences. This more perfect character of mathematics renders it the best possible means of developing the power of observation, for here alone can the results of induction from observation be verified with certainty, and here alone can the train of thought started by nature (that is, the physical universe)—namely, observation, induction, and deduction—be completely carried through. Moreover, the education of the individual differs from the life-history of the race just in this, that the pupil is made to pass through the essential stages of development without wasting his time on what the experience of former generations has shown to be unessential. In other words, education is selective history, and whatever mode of selection most thoroughly excludes the unessential is most economical, enables the pupil to master the largest amount of what is essential, and gives him most time to devote to the exploration of new fields when he shall have explored the old; that is, leads most rapidly to independent thought, the true goal of education. Furthermore, deduction reacts upon the earlier processes beneficially in that the conditions necessary for its prosecution suggest, not only the principles upon which it must itself be based, but also the elementary facts from which these principles are to be derived by induction. Thus it has come about that the facts to be determined by direct observation are very much more elementary in mathematics than in any other science, and are, therefore, the more readily observed and fixed in the mind. Unfortunately for the practice of education in general and for the popularity of mathematics in particular, the observational method of teaching our subject has been neglected, has never been suspected to be possible by some educators, and is considered by others to be altogether inappropriate. It is

perhaps unnecessary to say that a considerable part of the work of the kindergarten is the most elementary kind of mathematics; the pity is that this work is not sufficiently systematic, consecutive, and progressive, and is not continued along natural lines in the primary schools. I think that what I have said justifies the claim that mathematics is the ideal study for the inculcation of the habit of observation in the earliest stages of school life.

It seems to me that the immediate object of education can be best described as the formation of good habits, and that of liberal education as the formation of good habits of thought and expression; the acquisition of knowledge is the storage of food for thought, and, therefore, is a secondary object. The chief strictly mental faculties whose use is to be made habitual are attention, observation (which is not by any means the same as attention), concentration, and reason—just the faculties that are called into play particularly by the proper study of mathematics. But these faculties cannot be developed by precept; it is by practice alone that habits are formed, and it seems probable that they are most readily formed when the child is unconscious of outside influence; this would suggest that the child is to be led and not driven, and the surest and easiest way of leading him is by rousing his interest. The apathy of the teacher, his own want of interest, and his failure to arouse the interest of his pupils (which may require heroic effort on his part) are perhaps the most potent factors in the relative inefficiency of the schools in teaching mathematics as compared with other subjects. The child naturally takes most interest in that with which he comes into closest contact, in those studies of which he sees the most immediate, the most frequent, and the most profitable applications. The remedy for the present unpopularity of mathematics is to make it practical, to make it immediately useful, and to exclude from it everything that is not directly applicable to the child's world, certainly in the early stages.

I have spoken of mathematics as a science, but this is only one phase of it, and by no means the most important. The science of mathematics is only a means to an end. Mathematics is really an art; it has for its object the accomplishment of

something useful in itself; it is not a mere system of mental gymnastics. Mental training is, to be sure, of prime importance in any system of education, general or special — physical, manual, or intellectual. The athlete or the mechanic can do first-rate work only when his mind has been trained to think quickly and correctly. But mental training of a useful kind comes from practice in doing something, in accomplishing what is itself useful (or may be so on occasion), in overcoming difficulties, in acquiring good habits, especially in doing what is distasteful, if it be proper, or charitable, or agreeable to others. The habit of doing what ought to be done and the acquisition of the power of doing something well should be the chief aims of every self-respecting youth, and the schools should be so managed that these objects may be accomplished. The former result can be enforced only by a fixed curriculum, while the latter is often facilitated by elective studies, although it may well be attained without electives, if the curriculum is sufficiently broad. In this connection I wish to say that I have no sympathy with the notion that a child should never be required to do what he doesn't want to do. I often do what I don't want to do, and I regard it as one of my best powers that I can compel myself so to do. Unless the child acquires this power early, he is not likely ever to possess it in any high degree; when acquired, it is so useful that it may almost be said to cause one to wish to do what he knows is very distasteful to him. How much control of one's self such a power gives is evident.

I take the ground that the object of mathematical instruction in the schools is the development of power, of the ability to do something, and not merely the acquisition of knowledge regardless of its use. Knowledge is power just in so far as it enables its possessor to do what he could not do without it. I believe there is no kind of knowledge that cannot be made useful in action, and I claim that all knowledge should be imparted in such manner that this use can be made of it. Unfortunately, the greater part of the mathematics of the schools is popularly regarded as quite useless to the great majority of pupils excepting as a mental discipline; the bad name thus given to it (one

can hardly help saying deservedly, in the present state of things) is not due to any peculiarity of the subject, but simply and solely to the manner in which it is commonly taught — particularly to the want of purpose in such teaching.

Mathematics is an art; like other arts, it is characterized by its methods; as in the case of other arts, there are geniuses to whom it is a second nature — who absorb it through their pores, so to speak, with little or no assistance from others; doubtless there are some few who cannot grasp it at all, but the great majority of people can, if properly taught, acquire considerable facility in its practice, certainly sufficient for the purposes for which it is most commonly used. I speak now only of the elementary mathematics, the mathematics of the schools; I am far from thinking it advisable for those who have no special predilection for it to study the higher mathematics. Like other arts, also, mathematics has its technique, its system of standard modes of procedure derived from the experience of the great mathematicians, which must be thoroughly mastered before independent work can be undertaken with any hope of success; and this mastery requires years of hard work even for capable students. The mathematics of the schools, and practically all that is taught in the college, belongs to the technique of the art. Technique can be learned only by practice, and cannot be properly understood until it has become a habit, to be applied almost mechanically, without more thought than is necessary to keep the attention fixed on the matter in hand, without hesitation, and with absolute accuracy. Whoever is to know anything of mathematics must begin with the technique, and he who does not aim to become an expert mathematician will confine his attention to the technique. The mere computer, however skilful, however phenomenal, is only an unconscious practitioner of the technique, a skilled artisan, but not an artist.

The fact that what the child learns, or can be expected to learn, of mathematics in the schools is only a part of the technique of the subject has a direct bearing upon the methods that ought to be employed in teaching it. The teacher and the pupil have their separate rôles; neither can do the work of the

other. The teacher must take the initiative and show the pupil what he is to do and, by example more than by precept, how it is to be done; but, when he has acted his own proper part, he must still be the constant director and, if need be, prompter of the pupil, laying out his work for him and seeing that he does it. The attitude of the pupil should be that of an apprentice learning a trade; he has first to find out what is to be done and how he is to do it, and then he must practice it until he shall have acquired the proficiency necessary to do it skilfully, rapidly, and accurately. The question of why it is done in the manner shown ought not to be raised, at least not until the pupil has had considerable practice in the method and ample time to think about it. Reason is the highest faculty of the human mind and the slowest in its development. Children may ask questions, they are very inquisitive, but they do not naturally reason logically to any great extent, nor can they truly appreciate the force of explanations of whys and wherefores that may be given them, excepting in the simplest cases; and it is requiring too much of them to expect them to understand why certain processes are carried out in certain ways—it is as if you should expect them to understand why a word is spelled in a certain way; the fact that they are so carried out ought to be enough, and the ability to carry them out so is quite enough. Instead of explaining the reasons for the rules of arithmetic, for example, the teacher would do better to explain the meanings of some of the so-called practical problems that are to be solved by application of the rules. Professor Klein classifies mathematical mind as of three types, often more or less combined in the same individual—intuitive, formal, and critical; the critical type is sufficiently common to make it pretty certain that no really incorrect rule will find its way into the generally recognized system of technique, nor, being there, will long remain. Unfortunately, some of the text-books often used in teaching certain branches are not altogether free from the errors of former generations, for it is only recently that the ideas of modern mathematics have exerted any considerable influence on the schools in this country. But it requires the most untiring patience and ingenuity of the formal mathematician to develop

any branch logically, and the most strenuous efforts of the critic to make sure that the development is logical. No branch of mathematical technique, as expounded in the current text-books, not even much-lauded geometry, has a strictly logical foundation; every one of these branches is based upon fact as the mathematical world knows it by experience. To teach arithmetic upon a strictly logical basis would require the explicit statement of several hundred distinct propositions, and would impose a strain upon the mind of the pupil that no child could endure. If, then, we cannot teach mathematical technique logically, we ought not to make a pretense of doing so. When the pupil has become somewhat familiar with methods and with what may be called the fundamental facts of a branch of mathematics, he may be encouraged to analyze the methods and to determine the particular facts upon which they are based. Mathematics has been regarded as a deductive science, but all deduction must be preceded by analysis and induction, by which alone the fundamental principles can be even hypothetically determined.

The classification and formalization of mathematics has been only a sequel to the discovery of isolated facts, and was impossible until such facts were known. It is, likewise, impossible for the child to learn to reason logically until he has acquired a body of knowledge, and, in the ordinary course of events, his reasoning power will grow stronger and more acute as his knowledge increases. The chief function of the teacher in this work is to provide the pupil with food for thought graduated to his power of assimilation and, what is quite as important, connected and always progressive. Too much emphasis cannot be laid upon the importance of progress in mathematical exercises; if the pupil is not learning something new to him, he is probably losing control of what he had possessed. In mathematics, the opportunities for applying the principles involved in earlier work are so frequent that I am inclined to think it better, when a child does not attain the desired proficiency in one topic after what appears to be a reasonable length of time spent on it, to pass on to the next topic, in the hope that he may master the earlier principles gradually as he becomes more familiar with them, than to

compel him to stick to one thing until, as is likely to happen, he becomes disgusted with it or, what is just as bad, becomes apathetic.

While I disapprove of requiring or even encouraging pupils to discuss the reasons for mathematical methods before they are pretty familiar with them, there is one point that I regard as very important, although it is often neglected, namely, precise expression. The pupil should be required at every step, regardless of the time it may take, to state his problems, rules, processes, and results—indeed, everything that is connected with his work—in exact and grammatical language, preferably in his own words. It is not enough for the teacher to see that he understands a point; he must be required to state it, and his statements must be carefully scrutinized and openly criticised. The fearful prevalence among school children of the habit of using slang is, it seems to me, largely due to neglect on the part of the teacher to insist on the use of good grammatical English on all occasions. If children are not corrected whenever their language is bad, how can they be expected to acquire facility in the use of good language?

We are often led astray by mere words, especially in discussions between conservatives and radicals whose points of view are very different. I say that all instruction should be logical, and I do not mean that it should consist of specimens of formal logic presented as such. I regard explicitly logical and philosophical studies as out of place in the school curriculum. But the child must learn to think properly; he must get into the habit of drawing exact—that is, logical—conclusions. He cannot be taught this by precept; he will acquire it but very slowly and uncertainly, if left to himself. He must be guided in the right way, by example, by the constant exhibition of good forms, and the persistent criticism and correction of bad forms, whether his own or those of others. He must be shamed out of practicing what he knows is wrong. I think teachers are too apt to confine their efforts to the immediate requirements of the subject they happen to be teaching at the moment. The practice of the principles of gammar, of logic, and even of rhetoric must

be made compulsory in connection with all school work, although these principles may be formally unknown to the child. By such practice alone will the child learn the principles on which his future studies in these subjects as such must be based. It may seem strange that the logical habit is more certainly acquired to a considerable extent than the grammatical habit; but the former is recognized as advantageous, and even necessary, as the natural mode of determining actions, while the latter is regarded as a mere accomplishment of no particular utility to those who are to spend their lives in action.

The most essential element of success in school work is the personal efficiency of the teacher, and I cannot but think that it would be a great step forward to replace the text-books in elementary mathematics by collections of graduated exercises, leaving it to the teacher to give directions for the solution of the problems in his own way. Certainly, a pupil should never be expected to learn fundamental principles or methods from a text-book.

The first question to be answered in laying out a curriculum in mathematics is: At what stage of mental development—or, if you please, at what age—should the pupil begin the study of mathematics? I believe it is best to begin instruction in any necessary subject before the pupil has acquired of himself any appreciable knowledge of it; perhaps the best time would be when he is just beginning to think about it, if that time could be determined with any certainty. Such a course would save both teacher and pupil much trouble in eradicating wrong ideas that had been formed. This remark has particular reference to the fact that children generally come to the study of geometry with preconceived notions that are very detrimental to a proper appreciation of the importance of the subject as taught and its value as a branch of knowledge. The study of algebra as a distinct subject is objectionable in that the true significance of the subject as generalized arithmetic is thereby concealed, and in that the pupil is thus led to think that he has finished it when he has learned all that the text-book contains, whereas the subject practically includes the whole of modern pure mathematics. It seems to

me very important that the first ideas formed should be correct, and I do not see any greater difficulty in teaching the elements of mathematics to very young children than in teaching them the elements of drawing; indeed, these two subjects are very closely related, and might be taught together to some extent with advantage to both. The earliest instruction in mathematics, in my scheme, would be imparted by what might be called the kindergarten method, with a very gradual transition, as the mental development of the pupil progresses, into the more strictly scientific method. If I had to assign names to characterize the subject-matter, I should call that of the first two years, more or less, number and form, although I do not consider it wise to let the pupil know that he is learning any particular branch of mathematics; in fact, I propose to arrange the course in such a manner that it would be very difficult to determine just where one branch ends and another begins.

The curriculum that I propose is founded upon certain principles that seem to me to be essential to proper instruction in mathematics as a subject to be continued to the end of the secondary-school course. It is advisable to bear in mind that the mathematics of the schools is only a very small part of what is now known of the subject—the most fundamental part, certainly, and the most generally useful—and is, to some of our pupils, a preparation for still further work along similar lines. The description of the curriculum will be facilitated by a statement of the principles on which it is based.

1. Elementary mathematics is to be regarded as one subject. This is the keynote of my curriculum.

Neglect of this principle leads to false ideas of the nature of mathematics and of the extent of its various branches. I suppose mathematics is, to most school children, only a name used to designate arithmetic, algebra, and geometry, taken collectively; they see nothing common to these branches in subject-matter and methods, and get from them no notion of what the higher branches may be. They find that it requires a distinct effort to become familiar with the concepts of each new branch, and are often restrained from pursuing mathematical studies

farther than they are obliged to by a disinclination to make this effort. Moreover, they imagine that what they learn of each branch in school is practically all that is known of it, and thus put a wrong estimate on their attainments. I should even avoid the employment of technical names for the different branches, although such names are useful when applied to methods; certainly, the early work in arithmetic and geometry might be conviently designated as number and form, if names for them are thought to be necessary.

2. Mathematical instruction should be always connected, consequent, and progressive.

There should be no period of school life during which mathematics is not studied in some form. How much the pupil loses by discontinuity of work must be evident to every teacher immediately after the summer vacation, and yet there is a period of at least one year in the curriculum of most secondary schools in which strictly mathematical studies have no place. It is better to devote less time to the subject in some grades than to omit it entirely from any grade.

Each topic should be the immediate outgrowth of previous topics and intimately related to the preceding topic or, at least, to a topic very recently considered. In a curriculum so arranged no essential change in subject-matter or method will be perceptible to the pupil at any stage; he will not be aware of any distinct effort to assimilate new ideas, but each step will be to him a natural continuation of his previous course. Thus, the algebraical notation should be introduced at the earliest possible point in the study of arithmetic, certainly as soon as the child has acquired some fluency in the fundamental operations, and should be thereafter employed on all suitable occasions; there will then be an easy and natural transition from discrete number to algebraic expressions and equations. Algebra is, in fact, only a generalization of arithmetic involving an extension of the idea of number —"universal arithmetic," as Newton called it. This course will render it impossible to draw any hard and fast line between arithmetic and algebra—a desirable result, as I indicated in connection with the former principle. Again, demonstrational

geometry grows naturally out of observational geometry, in which simple demonstrations based largely upon the method of superposition will have suggested themselves more and more frequently as the work progresses.

There should be no time at which the pupil is not learning something new to him. Reviews should always take the form of new applications of old principles, for which there will be sufficient opportunity at any stage. Mere repetitions tend to weaken the child's interest in his work and to harden the mind to new impressions.

3. The work of each stage should be adapted to the child's mental development.

In the earlier stages observational and constructive methods should be employed exclusively. Terms should be defined only as they are needed for actual use, and never in anticipation of future needs, very few at a time, so connected that no one will be overshadowed by others, in words familiar to the pupil, and each definition should be accompanied by numerous and typical illustrations. Whenever it is possible, the types should be exhibited, and the pupil should be required to state in his own words what they seem to him to have in common; that is, the pupil should be made to frame for himself a definition derived from actual observation of typical cases. This is the historical method, and in its application the function of the teacher is to present suitable types in such variety that the child will readily eliminate irrelevant elements; in other words, it is the teacher's duty to abbreviate history for his pupils, in order that they may learn its essential results without being compelled to live the whole life of the past. Merely formal definitions without illustrations that the child can comprehend should be entirely excluded, but exactness of expression should be insisted upon in such definitions as are admissible and in all other statements.

4. Exact expression is a *sine qua non* of satisfactory work in mathematics.

I believe that mathematical studies are better adapted than any others to inculcate the habit of exact and correct expression, and that this is one of their most important functions as ele-

ments of a liberal education; in order to secure this habit, however, the teacher must subject inaccurate expression to constant and open criticism. The pupil should be required to state in his own words, but in idiomatic English and with such regard to style as corresponds to the knowledge of the vernacular that he may be reasonably expected to possess, all facts brought to his attention, the general principles he derives from the facts, and the conclusions he draws from these principles. It is a very common and grievous error for a teacher to say to a pupil, "Oh, I see that you understand that point; we'll pass on to something else," when the child has not so expressed his thought that there can be any certainty of its correctness. I feel that it would be impossible to insist too strongly on this point. But the ultimate object of such insistence is to make correct expression spontaneous, and, therefore, memorizing should be explicitly discouraged in mathematical studies, except in cases where retention in the mind is the main object. I know of nothing in elementary mathematics that need be committed to memory, excepting the arithmetical tables of addition, multiplication, weights, measures, and values, and a few formulæ of algebra and trigonometry. The propositions of geometry should be thoroughly understood, so that they can be expressed by the pupil in his own words, but they should not be memorized in set words nor ever quoted by number.

5. Every step taken should have a definite, evident, and useful object.

This principle is in accordance with the conception of mathematics as an art. Every application, however, must be to things with which the pupil is familiar and in which he takes a present personal interest. One of the great problems for the teacher to solve is how to excite an interest in matters to which the principles being taught are applicable. There should never be the least doubt whether the meaning of a problem proposed for solution is clear to the child's mind or not, and problems whose solution are of no practical value in themselves are to be systematically avoided. Any particular class of pupils should be treated according to the probable future requirements of its

members; but as a rule, technical questions should be made subordinate to general methods. In my opinion, no subject should be taught solely, or even primarily, as a means of mental discipline; I think that any kind of mental training that is valuable can be affected by forms of activity whose immediate products are useful; and I doubt whether real mental strength is ever developed by mental gymnastics. I think that some branches of mathematics have suffered very much from being regarded as valuable chiefly for their disciplinary effects.

6. Any topic about which the child is liable to pick up false notions if left to himself should be taught before such erroneous ideas have had a chance to fix themselves in the mind.

This applies to the use of words as well as to facts and methods. A good deal is said nowadays about the danger of too early instruction in certain subjects; for example, it is said that the child should not begin the study of arithmetic before his tenth year; and when I ask if he shall not be taught earlier to count, I am told that he ought not to receive systematic instruction in mathematics before that age. Now, I do not know what is meant by unsystematic instruction; it seems to me that all teaching should be what I call systematic; I do not see how absence of system in instruction can make any subject easier, nor do I think that a method that makes a subject unnecessarily difficult is suitable for any age. If the pedagogical objection is really to pure theory, I say simply that I do not believe metaphysics has any place in the school curriculum. Again, the child learns to best advantage when he is unconscious that he is being taught, and no mode of teaching that excites self-consciousness in the pupil is really good; but it is hardly possible to implant in the child's mind ideas that are entirely new to him without making him conscious of outside influence and of the fact that he is acquiring notions that did not originate with him; such instruction should be kept within the narrowest possible limits, and certainly not extend beyond the most fundamental elements, from which he can and should build up his whole mental world for himself under proper guidance and without apparent compulsion. The kind of self-consciousness that is injurious to the

child is the recognition of his organs, his mind as well as his stomach, as something having an individuality apart from his conscious being, his true "ego." But the belief that he is evolving what he learns out of his own mind is equivalent merely to the recognition of it as a logical consequence of certain premises, and is the basis of exact thought, the best product of education.

I should, then, begin instruction in number and in form at the same time—that is, at the very beginning of school life—and continue them throughout the course simultaneously, apportioning the whole time available for mathematical study in each grade between them in such a way that, at any stage, the pupil shall have acquired the knowledge of either that may be necessary for further progress in the other. If the work is so distributed, the child will never come to an application of number to form nor of form to number until he is prepared for it. The work along each of these lines must be logically consecutive and progressive, and should be connected as closely as possible with the work along the other line—if not with what is being done at the time, at least with previous work—so that the two shall be inseparably woven together in the child's mind. I think we ordinarily pay far too little attention to the application of number to geometry; in fact, under the prevalent conditions, the child gets hardly any practical knowledge of metrical geometry, of which the greatest use can be made in the actual affairs of life. I would make the study of mathematics consist always in doing something; I would make the theoretical part of geometry entirely subservient to constructions and calculations. The child should learn to use the ruler and dividers as early as possible, and neatness and accuracy of drawing—to a definite scale, whenever practicable—should be regarded as important elements of good work in geometry and its applications. By far the most important method of proof in geometry is the method of superposition, and any child can be made to understand it if it is presented in the right way, that is, in the concrete form. The great difficulty in it, at present, is that one figure is not actually applied to another, but the application is only imagined, and it is the want of geometrical

imagination that prevents many children from comprehending geometry. In the earliest stages the figures should be concrete, cut out of paper or other suitable material; and one actually applied to the other. In the course of time, after a sufficient number of actual applications have been made, the pupil may be exercised in imagining the applications, and, if his imagination is at fault, his errors may be corrected by actual applications. With practice under proper guidance all difficulties will disappear. But now the pupil has no time for such practice; he is rushed through geometry in a year, held to the demonstration of so many theorems a day, without regard to his preparation for the work and his comprehension of it. And what is it all for? The chief object seems to be that he may say that he has studied geometry, because the college requires him to be able to say that. Nevertheless, the right kind of geometry is of practical use and of daily application in some form or another, and it is this kind that ought to be taught in the schools. If anyone who had learned geometry in this way were sufficiently interested to care to read a formal presentation of the subject, he would find no difficulty in Euclid; but such reading is appropriate to philosophers and not to school children. It is evident to the child that he is accomplishing something when he is making a geometrical construction, and such constructions are just the things on which he gets the firmest grasp, and which he retains to a certain extent after geometry as a system has faded out of his mind. Such construction should, then, constitute a very considerable part of the work in form; the greater the care bestowed upon them and the more the pains taken with them, the more permanent is the effect of such exercises and the better are the things they represent understood. The metrical principles—which, in their elementary forms, are all derived by the method of superposition—should be constantly applied to practical problems, to the actual determination of lengths, areas, and volumes, in terms of various units. I have found that many boys who seem to have no difficulty in proving and remembering the formulæ for measurements are completely at a loss how to proceed when they are asked to apply them to concrete cases. This is not surprising, as nearly

all their practice in measurement is had in connection with the study of arithmetic at a time when their knowledge of geometry is entirely insufficient, whereas they have almost no practice in connection with the corresponding work in geometry. But it is not enough that these principles should be applied to the geometrical forms as such; they should be applied also to concrete objects whose shapes are sufficiently simple and to such as have forms approximately compounded of simple forms. In practical life, approximate measurement is quite as important as accurate measurement, and is often alone practicable; attention ought, then, to be paid it in the schools. As I have indicated, I would make practical use the basis of all instruction in mathematics. I do not mean that I would teach the child to do only those things that he may want to do in after-life, but that I would teach him to do as many of those things as possible as parts of a systematic course in mathematics.

What I have just said about the work in form is to be applied, as far as it is applicable, to the work in number also. All the principles learned should be applied to concrete cases within the child's actual sphere of interest, and this sphere must be so extended, if necessary, as to embrace a large number of applications of each principle. This is where instruction in arithmetic is often faulty, in that the teacher does not secure a sufficient extension of the child's sphere to include the applications made; such extension, if necessary, should be regarded as a preliminary requisite to each application. The comprehension of the conditions imposed by the statement of a problem, the recognition of what is required, and the perception of the relation of the required thing to the things that are given, are just as important as the knowledge of the process by which the required thing is to be found and the ability to carry this process out. This is something altogether different from the knowledge of reasons for the rules in accordance with which the fundamental processes are performed. The one is sense, perception; the other is meditation, philosophy. The best possible basis for a curriculum in elementary mathematics would be a series of problems in number and form whose solution should require a knowledge of all the

principles to be taught, arranged according to the proper order of the corresponding principles. These problems should be taken up consecutively, and each solved after the conditions necessary for its proper solution have been secured. The solution of other problems involving the same principles will furnish ample practice in the applications of these principles. In this connection, I am reminded of a Harvard professor who, when criticised for setting the same examination paper that he had set ten years before, replied that he would be perfectly satisfied with any student who could answer all the questions he had set in the last ten years. So I should be satisfied with the mathematical knowledge of any child who could solve all the problems in such a standard series. At all events, the solution of useful problems ought to be the main thing, and everything else should be subordinated to that; theory should be learned by the practice of methods in concrete cases.

In what is recognized as one branch, I suppose nobody doubts that the transition from one topic to another should be as gradual and as natural as the circumstances of the case allow. But the same is true also of the transition from one branch to another, in so far as the latter branch can be regarded as an outgrowth of the former. This applies particularly to algebra as an outgrowth of arithmetic and to demonstrational geometry as an outgrowth of observational geometry. Algebra is in reality nothing more than symbolic arithmetic; it is, in its elementary part, a mode of representing arithmetical processes and relations; its higher parts deal with the generalization of these processes and relations. Its symbolism makes it a more powerful instrument for the solution of numerical problems than common arithmetic, in that the results obtained by it are not restricted by particular numerical values of the given quantities. In arithmetic (and also in geometry) particular cases are discussed; the results would be valueless for general purposes if it were not that each particular case is considered as a typical representative of a class of cases to all of which the same discussion is appropriate, step for step, and that this discussion leads to analogous results in all cases of the same class. The difficulty is that the individual is left to his own

resources to determine, by unconscious inductive reasoning, whether the methods employed in the discussion of one particular case are or are not applicable to any other particular case that may arise. In algebra, on the other hand, a whole class of cases is discussed at once under such preliminary conditions as make it evident what particular cases belong to this class. In other words, the method of arithmetic is inductive, while that of algebra is deductive; but the deduction of algebra is based upon the induction of arithmetic, of which it is the immediate outgrowth. The early part of algebra consists simply in translating the language of arithmetic into symbolic language and *vice versa;* the earlier this translation is begun, the more readily will the child learn to think in the new language, and the easier will he find the study of algebra as such when he comes to it, because he will then have surmounted all the obstacles due to the mode of expression and will have to contend only with those difficulties that are peculiar to the generalization of number. He ought, therefore, to learn the language of algebra while he is still studying arithmetic—in fact, as early in the study of arithmetic as possible—and use this language on all suitable occasions, in order that he may have acquired fluency in it before he begins the study of extended number. This is in accordance with the pedagogical principle that difficulties should be overcome separately, as far as it is practicable. I do not mean that the child should be taught merely the notation of algebra, but that he should be exercised continually in carrying out the same lines of thought in the symbolic language of algebra that he would have to carry out in arithmetic, by which means he acquires unconsciously the fundamental notion of an equation and of the transformations to which an equation may be subjected. Due regard being had to the results derived by induction from the discussion of any particular problem by the purely arithmetical method, this method is as general as the algebraical method, although this generality is not so evident. The reason why some numerical problems are more readily solved by algebra than by pure arithmetic is that the symbolic notation enables us to carry out operations involving any numbers even before those numbers are

known. The objection that appears to me most likely to be raised to this early introduction of the algebraical method is that it encourages the child to use this method when he ought to be having practice in arithmetic; but I take the ground that the study of arithmetic is justified only in so far as it enables the pupil to solve problems, and that any problem ought to be solved by algebra if it can be better solved in that way than by arithmetic. Practice in the fundamental operations is the most important thing in arithmetic, and this practice can be had just as well in connection with algebraical work as without it.

What I have said about induction in arithmetic does not apply to the very first elements of the subject. The study of the fundamental operations—that is, of the relations of numbers to each other—has three stages. First, all the mutual relations of the very smallest numbers must be learned by actual observation and fixed in the mind; this stage ends with the commitment to memory of the tables of addition and subtraction (the latter table is only another mode of reading the former and need not be learned separately), which assures the immediate command of the results of observation. Second, the multiplication table must be thoroughly memorized; this is not a collection of the results of the child's personal observation; it would not be economical to require the child to verify all the numbers of this table, nor would such a verification answer any useful purpose; the mastery of the table is a necessary condition for further progress, but the table itself must be taken for granted as the result of the experience of others. The third stage is the study of the mutual relations of numbers in general based upon the tables of addition and multiplication of small numbers; our system of numeration, of which the elements will have been learned in the first stage, and whose indefinite extension constitutes the beginning of the third stage enables us to make this generalization. As I have said, the fundamental operations constitute the most important part of arithmetic as a subject of the curriculum; they should be practiced separately until they can be performed accurately and rapidly, in useful applications, as far as may be possible. It is astonishing how few people can add, subtract,

multiply, and divide with accuracy, to say nothing of rapidity, when we consider how much time is devoted to arithmetic in the schools. I was informed by an astronomer some years ago that it was almost impossible to find young men pursuing their studies in college on whose computations he could place any reliance. I attribute this state of things to the fact that the fundamental operations are neglected in favor of technical and especially mercantile applications, whose intricacies distract attention from the operations themselves. Algebraic symbols should be introduced as soon as the fundamental operations have been mastered. As to fractions, it seems to me simplest to treat decimal fractions by the rules for integers before the general principles of vulgar fractions are introduced; I take it for granted that the fractions whose terms are very small integers will have been studied in connection with those terms. The rest of arithmetic ought to be regarded as applications of the fundamental operations, percentage as an application of decimal fractions, and interest of percentage; mercantile applications should be reduced to the minimum and should involve only such transactions as the child can understand without much preparation; square root is best taught by the algebraical method, and cube root should be so taught, if at all. One of the great stumbling-blocks in arithmetic is denominate numbers; they should be taught only in the forms in which they will be actually used; many of them are mere curiosities not likely to be used by one out of a thousand. What I mean by "the forms in which they will be used" is illustrated by the table of long measure, which contains several units not now commonly employed and several others that are practically never used together. Especially should improbable applications be excluded. When the metric system of weights and measures shall have been generally adopted, the difficulties of denominate numbers will have disappeared, excepting in so far as they arise from the English monetary system.

When the purely arithmetical work is finished, algebra as such ought to be continued — not begun again, but continued from the point reached in connection with arithmetic. By this time the simple equation of the first degree in one unknown quantity will

be a familiar idea. The next step is naturally to the conception of negative number (I should say this also ought to come in arithmetic), and the development of algebra from this point will proceed in the usual way.

In form I should begin by teaching the pupil the names of the simpler plane figures and solids, putting into his hands models of a considerable variety of each form, naming their parts (vertices, sides, edges, and faces), making him count these parts (as an exercise in number, closely following his progress in that line). The child seems to have a veritable mania for names, coining words of his own and using those coined by other children, of which many have no meanings at all and yet are used in certain definite connections, so that there ought not to be any difficulty in teaching the names of forms. There seems to me to be no better concrete representative of a number than a geometrical form; I believe that the simultaneous study of number and form, while it gives an additional interest to the latter study, will greatly facilitate the assimilation of the former. The next topics are naturally the applications of figures to each other, measurement (of lengths, areas, volumes, and angles, in terms of various units, first arbitrary units and then those in common use), the use of the ruler and dividers, parallel lines (without regard to the theory), and similar figures. Of course, care must be taken to distribute the time between number and form in such proportions that progress in the one shall keep pace with that in the other. During this stage a number of the simpler geometrical theorems can be proved, but no systematic attempt to prove theorems should be made; the proofs given should grow naturally out of observation and construction; the child must be led gradually to see in what a proof consists and he will then devise proofs of himself in many cases. Then all the principles of measurement can be taught in their practical applications, and I should lay great stress on this part of the work; such measurements constitute the most important uses of geometry.

Finally, with this preparation, there is no real difficulty in teaching plane trigonometry as the cap-stone of elementary mathematics. From the time when the use of the ruler and

dividers has been learned, constructions with them should constitute a regular part of the work, each figure studied being accurately drawn by the pupil to a definite scale. When the child has grasped the nature of a proof, he should be encouraged to prove every result he obtains by inspection or otherwise and to state his reasons for the constructions made; the teacher should cause him to correct his errors by questioning and criticising; if such methods fail with a particular pupil, it is better to call on other members of the class to remove the difficulty than for the teacher to correct the error himself.

Such are the main features of the curriculum in mathematics that seems to me most suitable for the schools, most readily made effective, and most useful to the pupil when his course is finished. Perhaps it demands more effort of the teacher than the present curriculum, for I assume that all instruction will be given in the class-room, leaving only exercises to be done outside; but it will save time, and I am confident that the results will justify the effort even to the teacher.

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[This number is, in accordance with our custom, made up of papers read at the annual meeting of the Association of Colleges and Preparatory Schools of the New England States. It had been intended to include more than those published here, but unforeseen delays have prevented the authors from forwarding the manuscript in time for this number.—THE EDITOR.]

EDITORIAL NOTES.

GEORGE HERBERT LOCKE.

THE POSITION OF THE NONCONFORMISTS OF ENGLAND IN REGARD TO THE RELATIONSHIP THAT OUGHT TO EXIST BETWEEN RELIGION AND EDUCATION.

WHILE in this country we are busily discussing in a more or less theoretical manner the relationship that we think ought to exist between religion and education, the people of England are engaged in a real struggle which, though not as extensively advertised as the political struggle, is no less important in its effect upon the future of the social and political life of that country. From time to time we have indicated the important questions at issue in this contest and have tried to make clear the positions of the contending parties. We are therefore reproducing in this issue part of the speech delivered to the autumn assembly of the Baptist Union of Great Britain and Ireland in the Victoria Street Congregational Church, Derby, in October last, by Mr. George White, M.P. This is as calm and dispassionate a statement of the position of the Nonconformists as can be expected in such troublous times, and is enlightening as to facts and suggestive as to possibilities of rational relationship between these two great complementary agencies.

There is a common agreement now that it is the duty of the state to pass protective laws for the children, that it should assist their physical, mental, and moral development, and that it must provide educational facilities by which there is equality of opportunity, so that brain power may have free play and genius be cultivated to the advantage of the child and the nation. Upon these and kindred topics I do not enlarge. But such an education is admittedly incomplete. We of the Free Churches are as ready to admit this as Anglicans are to assert it, but we are constantly twitted with the statement that, had we been as generous in building schools as the Romanists and Anglicans, the present difficulties would never have arisen; and at the risk of wearying some of my audience, but for the benefit of the younger members of our body, I desire to restate the case in justice to those who have gone before us. The Free Churchmen of two generations back were at least as deeply interested in the work of education as any of their contemporaries, and so far as their means would allow, up to a certain time, they built and maintained schools. But they held two principles with great tenacity; first, that religious training must be an integral part of all education; and, second, that, as it was no function of the state to teach religion, education must be a voluntary, and not a state work. They were, however, soon convinced that they had overrated the power of voluntaryism to keep pace with the ignorance and indifference of the people, and that improvement in these respects was so slow that generations of children would

still grow up in deplorable ignorance, unless some other solution could be found. The position was therefore this: On the one side was a state established church, with a revenue of five or six millions for the support of its clergy, claiming church rates from all citizens to repair its churches, and eager at the same time to get grants from the state toward building or maintaining its schools. On the other side was a body containing few wealthy people, building all its own chapels and schools, paying the stipends of its pastors, and yet compelled on principle to refuse help from the state for education, because they felt that their education must include religious teaching. Such a contest was unfair and unequal, and could not be maintained, and, rather than the children should suffer, Free Churchmen threw themselves heartily into a movement to procure a truly national system of education, willingly sacrificing the teaching of their own particular beliefs, and accepting biblical teaching of an ethical and unsectarian character, as the most the state could with any justice be permitted to teach. On the other hand, the Anglican party, putting dogma as the first essential, claimed to keep the schools in their own control, obtained over three thousand building grants, and increased grants for maintenance, and were thus able to consolidate and extend the sectarian system.

No doubt in many cases the clergy practiced great self-denial in raising their portion of the funds. But the mainspring of their efforts was not education first, but dogmatic teaching. And so these two systems were started side by side. The national system would, with fair play, long since have held the field, but every advance it made was fought by the clerical party. More assistance was demanded by them from the state, until seeing, as they imagined, a final opportunity, they claimed to be wholly supported out of state funds, while keeping full control, and still maintaining religious tests. In this latter struggle we have fought, as our fathers did, for a national, as against a sectarian, system; for the people, and against the priest. And for the moment we are beaten; but one battle does not end this war. We contend that for the state to assume to teach religion through an organized ecclesiastical body is unjust; that in a community like ours no sectarian teaching should be endowed with state funds; and that, even were religious teaching excluded, grants of public money should not be administered, except under public control. We fly the flag of complete religious freedom for the state, and respect for the individual conscience, and under these colors we shall fight without ceasing, even to the extent of Passive Resistance, until the obnoxious clauses of the act are finally repealed. Meanwhile "the child in the midst" suffers, and upon our conscience there must be a burden until justice is done; but we repudiate the charge that we think more of the wrongs of Nonconformists than we do of the rights of the child. No cause can prosper by injustice — least of all education and religion; and such a retrograde step toward privilege and tyranny we resist in the interests of the child first of all. It is because we dare not voluntarily permit its young life to be dwarfed by unfair clerical influence, and its eternal interests jeopardized by the pernicious error taught in many of these schools, that we contend against this Act, and we do it as citizens endeavoring to protect the young of our nation from the baneful influence of the priest.

I hold most strongly that no system of education is complete which does not include religious training, and, therefore, the state ought not to attempt com-

plete education, but must be content to give as much as it can with justice and fair play to all its citizens. A strong Protestant democracy will always have a great variety of opinions within its ranks upon religious questions, and where these radical differences exist, dogmas or particular beliefs cannot be taught at the expense of the community, many of whom reject such teaching as mischievous error, without grave injustice to parents and citizens and without confronting the teacher with a religious test to which he ought not to be subjected.

Is it, then, the right or the duty of the state to say the Bible shall not be permitted as a schoolbook? Certainly not. The Bible is the oldest book in the world, it contains a vast repertoire of historic and ethical teaching, dealing largely with the history of an old and remarkable people. It is a book which touches human life on all sides except its sectarian side, and must, therefore, be a great educator. Put into the hands of trained teachers, taught free from clerical interference and a clerical atmosphere, it can be made the vehicle of teaching in the best possible way those moral truths which every good citizen desires the child to learn, without inflicting the smallest wrong upon any man's conscience. The fundamental error against which we have to contend is the belief that no training can be religious which does not deal with theological doctrines or dogmas irrespective of the age and capacity of the child, and the kindred error that Bible religion alone is not sufficient, but must be added to by the catechisms and traditions of men. Place the Bible then, side by side with your other books of history, biography, and poetry; it is superior to them all. For the state to prohibit the introduction of the Bible, while it lays down no instructions as to what other books are to be admitted, though more or less saturated with Bible truths, is to draw that sharp and yet wholly inaccurate line between sacred and secular which, as Christians, we should do our best to blot out. The true line of demarkation for the child is not between secular and religious, but between secular and moral training on the one side, and sectarian teaching on the other, and it is the endowment of this teaching and the compulsion upon the children to receive it against which we shall continue to protest.

To take a selection from the Bible, comprising poetry, history, biography, and ethics, and use it in the class with other class-books, would satisfy the vast majority, while protection could be given to the very few who would object. But so long as a large portion of the Established church and the Romish church contend that "simple Bible religion is worse than no religion," and claim that the deficiency shall be made up by the teachings of their own church, under their own control, but at the public expense, so long will education be the battle-ground of priests against people. The question is one of fair play to one-half the children of the nation, and of conscience to one-half of the adults; and we Free Churchmen are pledged by all our past history and our present and future existence to fight against such claims as a gross infringement of religious equality and constitutional liberty.

Far better for the Bible to be excluded altogether, if that were the *only* way by which we could escape the present sectarian strife, and provided the churches were prepared to undertake the religious teaching. But I see no reason to place any ban upon a book which is prized by so many of our people, and from which numerous selections can be made helpful to the real training of children and suited to their capacity; and with complete popular control in all our schools this

would be done without risk of theological tenets being taught. I should make no provision, or allow any provision to be made, for religious teaching out of school hours in council schools, but by renting the denominational schools for certain hours in the day opportunity would be left for special religious teaching, if the church concerned desired to give it; and, of course, any expense must be met and paid for out of private funds.

This is not a complete education and none are more ready to admit it than Free Churchmen, or more anxious to see it completed; but we hold that it is all the state *can* do or has a *right* to do. It is no more a godless system because it does not teach dogma, than it is wicked because it does not undertake to feed and clothe the children. These things belong to other departments, and whatever the state may have to do with the latter, it has no right to touch the former. A child can make a good citizen without being taught the doctrine of the Trinity or the Atonement, and if we think, as we doubtless do, that it is most desirable at some suitable time these doctrines should be taught, let us take opportunities voluntarily placed in our way when we can teach them without injustice or offense.

The paths, then, by which I have endeavored to lead you are these — the needs of the child secular and religious, and the influences by which both these needs may be met, viz., the home, the state, the church. The home, failing in the majority of cases to meet the needs, the state steps in to supply them; but I have shown you that from the very nature of our complex civilization and variety of religious beliefs, as also from past experience, it is not possible for the state satisfactorily and with justice to all to undertake sectarian teaching, and that it ought not if it could. For it to take one church under its protection is a grievous wrong to all the rest, and to take all by a species of concurrent endowment is to make itself an instrument for the propagation of error and to compel the citizens to be sharers in its guilt. This, then, leaves the church master of the field in its own proper domain, that of religion and conscience, and lays upon the advocates of this view the great responsibility of completing the training of the child. The day school gives the knowledge; the church and Sunday school must seek to add the devotional and spiritual training by which the skeleton may be clothed and religious character formed.

NOTES.

ASSISTED COLLEGE IMMIGRANTS.

THREE DIRIGO colleges—the University of Maine, Colby, Bates—have established an intercollegiate board of arbitration, to which will be referred all athletic controversies arising among them. This is the first bit of clear blue in the wide and cloudy firmament of intercollegiate sport, a sky prolific in thunder and lightning. It is vain to look for any extension of that azure rift.

Bates and Colby and the University are only simple little colleges. They have their troubles and squabbles, but their worst war is peace to the perpetual hostilities or armed neutralities of the big colleges. Besides, these sophisticated institutions have customs which are not only dear, but expensive, and diplomatic and subtle ways of getting the better of one another.

Their pickets, scouts, and spies are always in the enemy's country, visiting his feeding schools, cutting off his supplies. Is Bill Jones, who has the making of a great full back in him, spelling out his Cæsar at the Blinktown Classical Academy and gratifying the wishes of a proud mother by fitting for Blank? Along come the polished ministers plenipotentiary from Harvard, Yale, Princeton, Columbia, or Pennsylvania. They reason with that young man. They are so eager to have him get a good education that they even offer to pay his way through college. The young man, flattered by such attentions and such offers, decides to give Yale, let us say, the benefit of his presence. The New Haven atmosphere looks most congenial. But the rival Talleyrands are always watching him. If he is Yale's as a sub-freshman, Columbia or Princeton may lure him away by the time he is ready to "enter college." And even after he has passed his examinations he may be induced to change his mind.

Is this enthusiastic devotion to amateur sport unknown in Maine? Surely there must be many Maine boys who have gone elsewhere as assisted college immigrants. At any rate, the large colleges will not give up a habit so advantageous to education. We expect to see some of those curious gentlemen of leisure, who pass their lives happily in "rooting" for old Blank and in contributing to the athletic subsidy and corruption fund, establish an endowment the income of which will be used in defraying the college expenses of worthy young football students.—The New York *Sun*.

NEW YORK in these days is not a city of small things, and the executive committee of the board of education has approved the contracts for an enormous schoolhouse, which, with the outlay for the land upon which it will stand, will represent a total expenditure of more than a million dollars. This

extensive edifice will be constructed on the crowded East Side at Essex, Hester, and Norfolk streets. It will contain the amazing number of 124 class-rooms, and nearly forty-five hundred little men and little women will pass within its doors. Elevators will carry the children to the upper stories of the half-dozen floors.

THE type of motor which has been publicly and privately tested near Schenectady in the last few days for hauling canal boats possesses several features which distinguish it from any of the dozen or more already tried in this country and Europe.

The machine is virtually an electric locomotive, running upon a railway along the tow-path, and hitched to a rope which pulls the boats. It rides upon a single rail, but in order to accommodate motors drawing boats in the opposite direction a second rail is provided, parallel with and near the first. In a certain sense this road is elevated. For a reason about to be mentioned, it is necessary to have a portion of the mechanism reach under the rail, as well as above it. To be more exact, the lower part of the machine extends under the stout I-shaped steel beam on which the rail rests; but the principle and requirements are the same. Space enough to allow freedom of movement must be left between the permanent structure and the ground.

The most novel feature of the design is the method by which "adhesion" is secured. Weight alone might not suffice. Consequently, means have been provided for gripping the railway between the wheels above and the wheels below. Such a pressure can thus be brought to bear that slipping is almost impossible. The same idea has been worked out in another way by Ganz &

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Co., electrical engineers at Budapest. When a competitive trial was made on a canal near Berlin a few months ago, a motor supplied by that firm was one of twenty that were tested, and it gave more satisfaction than most of its rivals. In the Ganz motor a solitary rail was embraced between two wheels that slanted toward it, one on each side. In the Schenectady machine the grasp is more direct, and is exerted vertically. No doubt there are other features which differentiate it still further from the Hungarian model.

The motive power used with the latest American machine is electricity. Gasoline or even steam could be used instead, but they have their disadvantages. In the pending experiments a direct current is used, but in case the system is ever installed it is thought that an alternating current would be employed. That is a comparatively unimportant detail. The current is now taken from an overhead wire by the typical trolley pole. For these features the third rail and sliding shoe might, perhaps, be substituted. Still, the form of conductor is not essential. The main novelty is the gripping mechanism whereby adhesion is obtained.

The machine now on trial weighs 12,000 pounds (six tons), and can develop eighty horse-power. Any speed which may be thought desirable can be got out of it. The designer is said to be an engineer of the New York Rapid Transit Commission. To construct a mile of railroad of the type here outlined would probably cost $18,000. These figures do not include the motors.

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AT the annual meeting of the Amateur Athletic Union, held in New York, delegates representing organizations from the Atlantic to the Pacific were present. Several proposed amendments to the constitution were under discussion. The record of 9:28⅘ for the two-mile run, made by Alexander Grant on September 25, 1903, at Travers Island, was accepted. An amendment to the constitution, providing for a National Legislation Committee to consider and settle disputes over the registration of athletes, where two or more sectional associations are concerned, was adopted. Other records for 1903 allowed by the association included the following:

70 yards, low hurdle race, five hurdles—L. G. Blackner, New York, Feb. 28. Time 8⅗ seconds.

75 yards, high hurdle race, six hurdles—M. Bockman, Milwaukee Athletic Club, March 7. Time 7 seconds.

120 yards, high hurdle race, ten hurdles—E. J. Clapp, Berkeley oval, New York, May 30, 1903. Time, 15⅗ seconds.

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70 yards run—W. A. Shick, Jr., New York, Feb. 28. Time, 7⅕ seconds.

Three-legged race, 60 yards—W. S. Edwards and P. A. Sayles, New York, Jan. 15. Time, 7⅖ seconds.

Three-legged race, 100 yards—W. S. Edwards and P. A. Sayles, New York, Aug. 11. Time, 12 seconds.

Throwing 56-pound weight, unlimited—J. S. Smithell, New York, Athletic Club, New York, Sept. 7. Distance, 38 feet 5 inches.

Putting the 42-pound stone—J. S. Mitchell, New York, Sept. 7. Distance, 26 feet 8½ inches.

A large number of swimming records were allowed, including:

50 yards straightaway, across stream—David Gaul, Philadelphia Swimming Club, Lafayette Pa., Aug. 15. Time, 31 seconds.

100 yards straightaway, across tidal salt-water—Charles Ruberl, New York Athletic Club, Travers, N. Y., Aug. 1, 1903. Time, 1:05⅕.

200 yards, bath, seven turns—Charles Ruberl, New York, March 7. Time, 2:28⅘. Also intermediate record for 125, 150, and 175 yards.

500 yards, 19 turns—Joseph W. Spencer, Columbia University, New York. Feb. 14. Time, 7:01⅖. Also intermediate records for 225, 250, 275, 300, 325, 350, 375, 425, 450, and 475 yards.

900 yards, across tidal salt water, 6 turns—Charles Ruberl, New York Athletic Club, Travers Island, Sept. 11. Time, 11:44⅗. Also intermediate record for 550 yards.

One mile, across tidal salt water, 45 turns—Charles Ruberl, Travers Island, Sept. 11. 28:05⅗. Also intermediate records for 900, 1,100, 1,210, 1,320, 1,540, and 1,650 yards.

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THE trustees of Cornell University have recently approved the architects' plans for what is called the "New Cornell." This plan includes plans for Halls of Physics and of Languages, to be erected immediately at a cost of a quarter of a million dollars each. It also provides for an elaborate scheme of dormitories on the slope west of the library, and an administration building, a huge auditorium and gymnasium, a building for botany, and one for agriculture, on the present campus. By this development Cornell will make adequate use of what has been pronounced the finest university site in the world.

The preliminary announcement of Cornell's summer session for 1903 is at hand. We note with interest that among the ninety-eight courses offered there are sixteen devoted to geography and its underlying science. These courses, under the management of Professors Tarr, Brigham, and Charles A. McMurry, assisted by Principals Emerson, Whitbeck, and Carney, constitute a summer school of geography — something that, so far as we are aware, has never been before undertaken by any American university. Among the names of teachers from other institutions we note the following: Professor A. P. Brigham, of Colgate University (geography); Dr. Charles A. McMurry, of the DeKalb, Ill., Normal School (geography); Professor John C. Rolfe, of the University of Pennsylvania (Latin); Principal C. N. Cole, of Oberlin College, Ohio (Latin); Principal Philip Emerson, Lynn, Mass. (commercial geography); Supervisor R. H. Whitbeck, Training Department of the Trenton, N. Y., Normal School (geography).

As an index of the growing favor with which summer sessions of universities are viewed by teachers, we note from the new Cornell *Register* that the attendance of the summer session of 1902 increased nearly 30 per cent. over that of the preceding year. We learn also that the appropriations for next year have been advanced 25 per cent.

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respect for others. To bring him suddenly and forcibly under the rule of "must" would, in this day and place, where we have no compulsory education laws, deprive the school of the privilege of making a citizen of him. Such coercion and compulsion as may be permissible in other schools cannot well be used with this class of children. They are received into the school by the teachers kindly, worked with patiently, given a motive for right doing, and gradually interested in the work of the school. It has been exceedingly gratifying to me to witness the transformation in the lives of these little children. The teachers have not limited their work to the walls of the schoolroom, but have gone out into the homes of the community and made such visits as would stimulate interest in the school and in the education of the children. They have provided, at very little expense, bi-weekly parents' meetings or community gatherings, where the adult friends of the school, or enemies if they please to come, are gathered and received, not condescendingly, but in a cordial, hospitable manner entertained and edified for a short time, and given some little refreshment. The school is endeavoring to do well its work of making good citizens of the children of the working poor.

ANNOUNCEMENT has already been made of the selection of Boston as the next place of meeting of the National Educational Association in convention, July 6 to 10, 1903. A local committee will be appointed at an early date, which will spare no pains to provide for all the needs of the convention in the most complete manner. Attention is herewith called to several matters of special interest. Instead of eight general sessions, as in former years (six at Minneapolis), but five such sessions will be held at the Boston convention, and they will occur on the evenings of Monday to Friday, inclusive. The forenoons of Tuesday to Friday, inclusive, will be assigned to department meetings. No sessions will be held in the afternoons, but, instead, a large number of N. E. A. excursions at special rates, under the conduct of competent guides, will be planned for each afternoon to enable

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the members to visit with the greatest facility and profit the various points of interest in and about Boston. The Executive Committee at its recent meeting reaffirmed the past policy of the association, that in arranging for transportation to the annual convention, no "official routes" shall be selected or announced which will tend in any way to divert business from the legitimate territory of any line to another line. The policy referred to, which applies alike to the initial lines and to the lines terminal in the convention city, recognizes that wherever several lines have equal claims on the business of any state or district, they have equal claims on the aid and co-operation of the officially appointed director or manager. This does not prevent the formation of parties to go by certain specified routes, providing all lines in interest are regarded as alike "official," and are given equal opportunities and official assistance in organizing such parties. No legitimate advantages can come to the work of any director or manager by the adoption for a state or district of an "official route," while the association would be seriously embarrassed in its relations with the transportation lines by such action. No other convention body has, in recent years, been able to secure such favorable rates, routes, and ticket conditions.

A meeting of the presidents of the eighteen departments of the association will be held in Boston about January 1 for the purpose of conferring with each other and with President Eliot as to the programs for the Boston convention. The prominence which will be given to the department programs is due to a conviction on the part of the president and Executive Committee that the most important work of the association may be done in the department meetings, if due care is taken in organizing the programs for these meetings. The usual rates and ticket conditions have been granted by the New England Passenger Association, viz., one fare for the round trip plus the membership fee, with provision for extension of tickets for return until September 1 on the deposit plan. Connecting associations will, without doubt, take concurrent action.

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NOTES CONCERNING THE DEPARTMENT OG EDUCATION AT THE UNIVERSAL EXPOSITION, ST. LOUIS, MO.

The Department of Education at the Universal Exposition was organized in October, 1901, and has had nearly a year of preliminary work. The director of the department is Mr. Howard J. Rogers, of Albany, N. Y., whose exposition experience was gained as superintendent of the New York state educational exhibit at the Chicago Exposition, 1893, and as director of education for the United States commission at the Paris Exposition of 1900. As an Advisory Committee to support Mr. Rogers the National Educational Association has selected the following men:

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exhibit of the educational resources of this country, and to secure for comparison and for scientific study an exhibit from all foreign nations noted in any way for educational progress. The facilities placed at the disposal of the chief of the Department of Education by the executive authorities in St. Louis have been such as to render possible the accomplishment of both these objects. There are at the present time about ten of our great commonwealths which are actively engaged in the preparation of a thorough exhibit. Others are awaiting the action of the state legislatures which will meet in January, 1903, to provide the ways and means for the development of an exhibit. Three of the largest municipalities of the country — New York, Chicago, and St. Louis — have taken the preliminary steps, and others are giving the matter favorable consideration. The great colleges and institutions of learning of the country have also responded most promptly, and oxhibits are now being prepared from Yale, Columbia, Cornell, Chicago, Illinois, and many others. Other institutions of equal rank have the matter under consideration, and favorable decisions are anticipated.

The American Library Association has appointed a special committee for the preparation of an exhibit of library methods and resources. The agricultural and mechanical colleges and experiment stations of the country have united for a great collective exhibit, for which they have asked from Congress an appropriation of $100,000, which there seems every likelihood of their receiving. The four largest art schools in the country are applicants for space.

The industrial and technical institutions of the country have already responded generously to the invitation to exhibit.

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The education of defectives will be an innovation in exposition methods, as the schools for the blind and the schools for the deaf and dumb in this country have both decided to maintain a model school in actual operation on the exposition grounds during the entire exposition period.

The exhibit of publishers, manufacturers of school furniture, school apparatus and school appliances will be larger than ever before, and the facilities which can be given them are superior to any heretofore granted.

The participation of foreign countries in the Department of Education is most satisfactory, inasmuch as four of the nations which are of the greatest interest to the United States, and which have exercised the greatest influence upon our own institutions — namely, England, France, Germany, and Japan — have decided to make extensive educational exhibits. Many other nations have also applied for exhibit space. The value of an educational exhibit on the above lines is easily demonstrated to everbody, and the permanent benefit lies in the opportunities for comparison which it affords, the investigations which it inspires, and the acquaintances and friendships which it engenders. It should always be borne in mind that many of the most far-reaching results, both in the general education of the public and in the special processes of schools, are due to international expositions. The most notable instances are the development of industrial art as the result of the Crystal Palace exhibition in 1851; the spread of manual training and industrial drawing, as a result of the Centennial Exposition in 1876; the reorganization of primary instruction in France, as a result of the exposition of 1878; and the rapid growth in art education, in civic improvement, and in art ideals in this country, as a result of the Columbian Exposition of 1893.

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THE Forty-second Annual Convention of the National Educational Association will be held in Boston, Mass., July 6–10, 1903.

Rates.—A rate of one fare for the round trip, plus the $2 membership fee, has been granted by the railway lines of the New England Passenger Association, the Passenger Department of the Trunk Line Association, and the Central Passenger Association, and will doubtless be concurred in by all other railway associations of the United States and Canada. *Tickets will be extended for return until September 1* on the usual deposit plan.

The local committees.—The local convention committees at Boston are now fully organized and have already formed extensive plans for the business and the entertainment of the convention.

The state Directors of New England will meet in Boston, February 17, to formulate plans for systematic co-operation with the local committees.

The American Institute of Instruction will also co-operate by keeping open house on Copley square, during convention week, for the entertainment of visiting members of the association.

Edward R. Warren, of Boston, has been appointed secretary and chairman of the Local Executive Committee, and, with his several associates, will have entire charge of all local convention interests.

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Among the excursions already planned may be mentioned a "Harvard afternoon," with rare opportunities for inspecting the treasures and enjoying the atmosphere of this great university. Tally-ho rides, steamer, railway, and trolly excursions to various points of interest will also be arranged for each afternoon of convention week. These excursions will be under the direction of the local convention committees and will be provided with a

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Correspondence.— Application for entertainment in Boston, or for other local information, should be addressed to EDWARD R. WARREN, Secretary Local Executive Committee, Room 701, No. 60 State Street, Boston, Mass. For information regarding railroad rates, programs, membership, and other association interests, apply to the undersigned.

IRWIN SHEPARD,
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Winona, Minn.

THE twelfth annual meeting of the Harvard Teachers' Association was held on Saturday, March 7, in Sever Hall, Harvard University. The topic for discussion was: "The Time Limit of Secondary Education and Expenditures for Education." The speakers were Thomas M. Balliet, superintendent of schools in Springfield; George I. Aldrich, superintendent of schools in Brookline; William C. Collar, head master of the Roxbury Latin School; Charles J. Lincoln, head master of Dorchester high school; Edwin P. Seaver, superintendent of schools, Boston; Rev. Paul Revere Frothingham, Arlington Street Church, Boston; and Robert A. Woods, head of the South End House, Boston.

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"No, in very truth, it is not. Watch over your child, as it struggles for breath on the outermost verge of life, or see your wife follow the child to that outermost verge, beside herself for anxiety and sleeplessness — then love will teach you that *life comes first.* And never from this day on will I seek God or God's will in any form of words, in any sacrament, or in any book or any place, as if He were first and foremost to be found there; no, life is first and foremost — life as we win it from the depths of despair, in the victory of the light, in the grace of self-devotion, in our intercourse with living human kind. God's supreme word to us is life, our highest worship of Him is love for the living. But never more shall words be the highest for me, nor symbols, but the eternal revelation of life. Never more will I freeze fast in doctrine, but let the warmth of life melt my will. Never will I condemn men by the dogmas of old-time justice, unless they fit with our own time's gospel

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—From *Björnstjerne Björnson*, by W. M. PAYNE, in *The International Quarterly* for March, 1903.

THE emphatic success of Hertwig's General Principles of Zoölogy in this country has moved Messrs. Henry Holt & Co. to issue the author's *Text-Book of Zoölogy* translated and edited for American students by Professor J. S. Kingsley, of Tufts College. The earlier book was but the first part of this work, which the publishers will issue this month. This has an international reputation, having been used in Germany, Denmark, and Sweden, and translated into French and Italian. The American edition will contain over six hundred cuts, many of them not to be found in the German edition. Professor Hertwig considers the problems of this science both historically and in the light of modern research.

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did. They do not have to be taught; they are taught from the jump. The bird sings at the proper age, and builds its nest, and takes its appropriate food, without any hint at all from its parents. The young ducks take to the water when hatched by a hen as readily as when hatched by a duck, and dive and stalk insects, and wash themselves just as their mothers did. Young chickens and young turkeys understand the various calls and signals of their mother the first time they hear or see them. At her alarm note they squat, at her call to food they come, on the first day as on the tenth. The habits of cleanliness of the nestlings are established from the first hour of their lives. When a bird comes to build its first nest and to rear its first brood, it knows how to proceed, as well as it does years later, or as its parents did before it. The fox is afraid of a trap before he has had any experience with it, and the hare thumps upon the ground at the sight of anything strange and unusual, whether its mates be within hearing or not. It is true that the crows and the jays might be called the spies and informers of the woods, and that other creatures seem to understand the meaning of their cries, but who shall presume to say that they have been instructed in this vocation? Mr. Long would have us believe that the crows teach their young to fly. He might as well say that the rooster teaches its young to crow, or that the cock grouse teaches the young males to drum. No bird teaches its young to fly. They fly instinctively when their wings are strong enough.—JOHN BURROUGHS, in the March *Atlantic*.

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The anxious mothers cry.
"Because we cannot weave it in,"
The teachers do reply.

—N. P. C., in Linden Hill *News*.

THE publication by Ginn & Co. of *Wood Folk at School*, a volume of nature-study by William J. Long, condensed from his *School of the Woods*, calls renewed attention to the recent attack made by John Burroughs upon the veracity of his younger rival. Now that the smoke of conflict has cleared away, it is manifest that Mr. Long has been a keen observer and a truthful recorder, and that Mr. Burroughs passed the bounds of courtesy and true criticism in denouncing the writings of a younger man simply because they contained the record of facts and impressions which had never come to his personal knowledge. In his *Wood Folk at School* Mr. Long assures us of his truth and exact observation, and he writes with a power which convinces the student that he may rely upon both his facts and his inferences. We have already warmly commended his *School of the Woods*, and the same praise may be given to it in its briefer form. The illustrations are the work of Charles Copeland, and the book forms the fourth volume in the "Wood Folk" series.—Boston *Transcript*.

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THE MACMILLAN CO. has published a volume on *American Railways*. This is a reprint, considerably amplified, of a series of articles that have appeared in the London *Times* from the pen of its special commissioner, Mr. Edwin A. Pratt. The *Times* sent Mr. Pratt to this country to make an investigation of the subject of our railroads. The volume, which runs to a little over three hundred pages, is likely to have some importance on account of the author's knowledge of his theme, and also on account of the special advantage a book of this sort has when written by the pen of a student who looks upon the subject from the outside.

PROFESSOR JOHN B. MCMASTER is the author of three of the most important chapters in the seventh volume of *The Cambridge Modern History*, the one devoted to *The United States*. Those are the ones dealing with "The Struggle for Commercial Independence (1783–1812)," "The Growth of the Nation (1815–1828," and "Commerce, Expansion, and Slavery (1828–1850)." Professor McMaster's specialty has been the growth of the United States and the life of its people since the close of the Revolution, and Americans will be gratified to learn that the account of the building of the country for this important work has been intrusted to so capable an authority and so delightful a writer. Save for the account of the War of 1812, Professor McMaster tells the whole story of the United States from the Revolution to ten years before the Civil War, and he tells it, as might be expected, with an abundance of picturesque detail. The fact is of consequence because this history represents what Europe will think of us for the next quarter-century.

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THE college requirements for reading for admission in 1906, 1907, and 1908 include Tennyson's three idylls, "Gareth and Lynette." Lancelot and Elaine," and the "Passing of Arthur." These are collected, with an Introductory Sketch and Notes, in a new issue of the "Riverside Literature" series. The book contains a fac-simile page from a copy of the first edition of Mallory's *Morte d'Arthur*, printed by Caxton in 1485, and a portrait of Tennyson.

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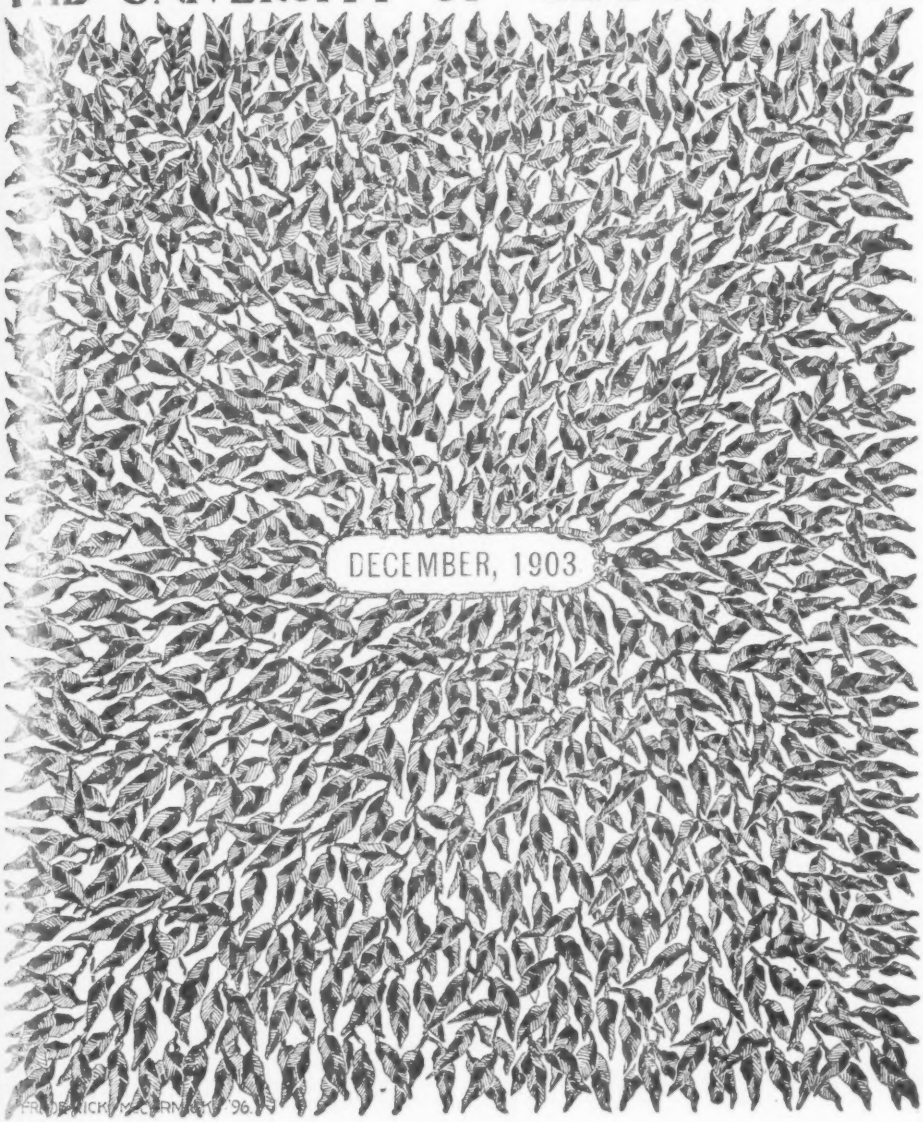

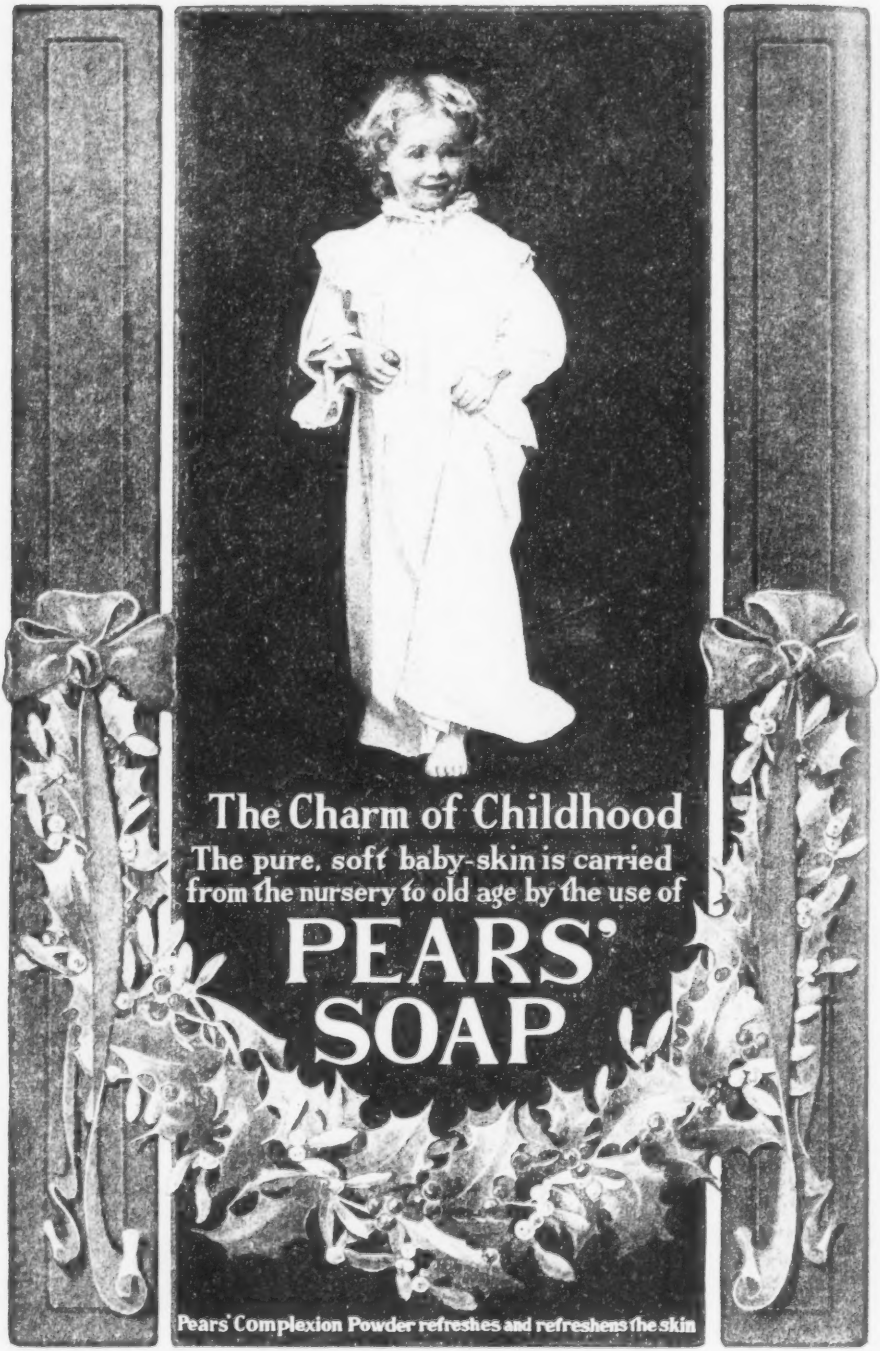
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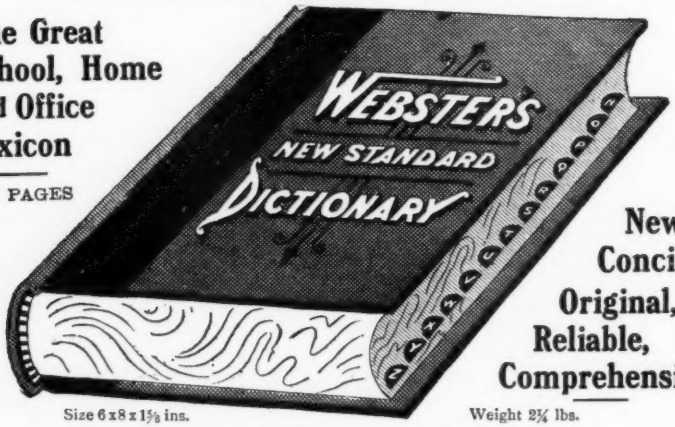

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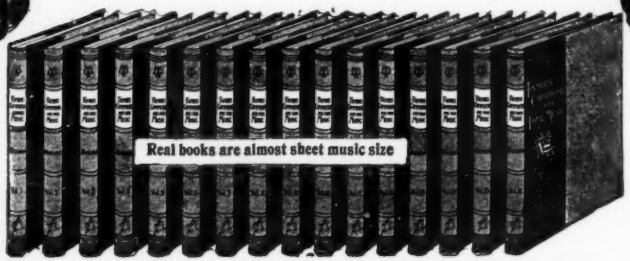

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from teachers in High Schools in the states of Massachusetts, Illinois, Pennsylvania, Ohio, Indiana, Michigan, Iowa, New York, California, District of Columbia, and Minnesota.

The Foreign Correspondents

Mr. Foster Watson, Professor of Education in University College, Aberystwyth, Wales, has succeeded Mr. Wm. K. Hill whose increased duties in connection with his position in London University have caused him to relinquish all his journalistic work; Mr. Watson will contribute at least two articles during the year on the situation in England. Dr. Oscar Thiergen of the Royal Cadet College, Dresden, is our correspondent in Germany.

The Special Numbers

The experiment of issuing numbers devoted to special phases of educational endeavor has proved very successful and we have received many congratulatory letters on the May number devoted to **Athletics,** the

September to **Commercial Education,** and especially the illustrated double number in June, devoted to **School Architecture.** The same policy will be pursued in 1904 and arrangements are being made for at least three special numbers.

The Book Reviews

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The Editorial Notes

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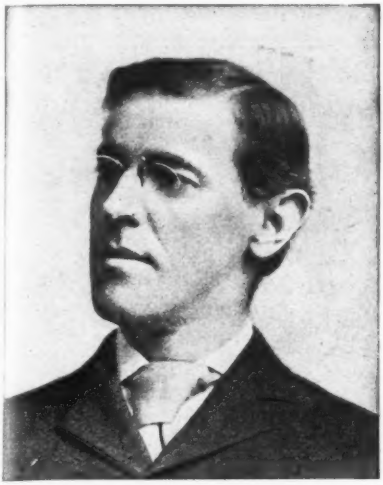

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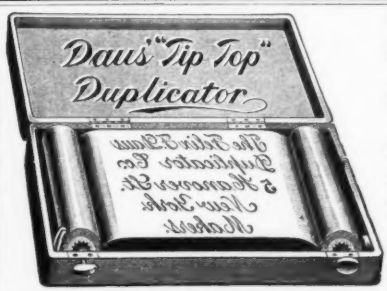

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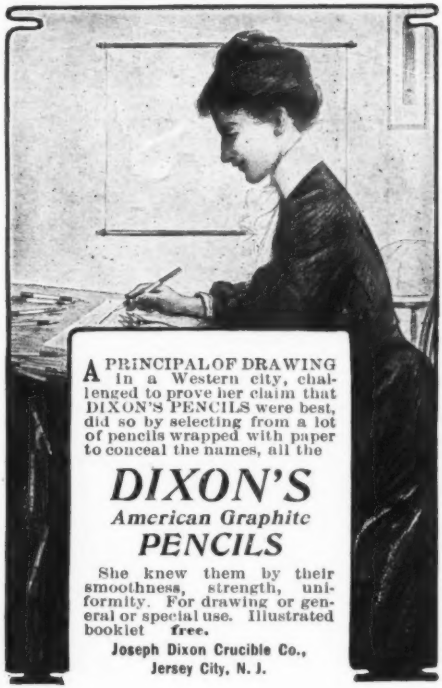

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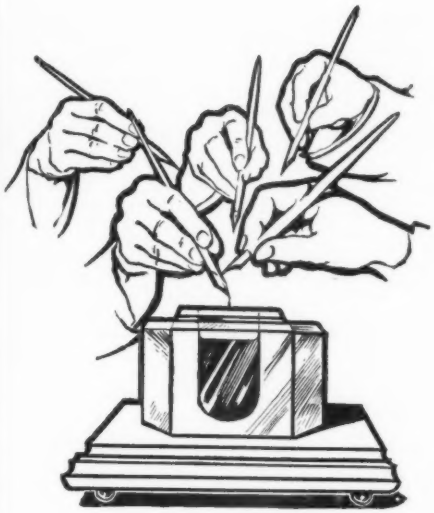

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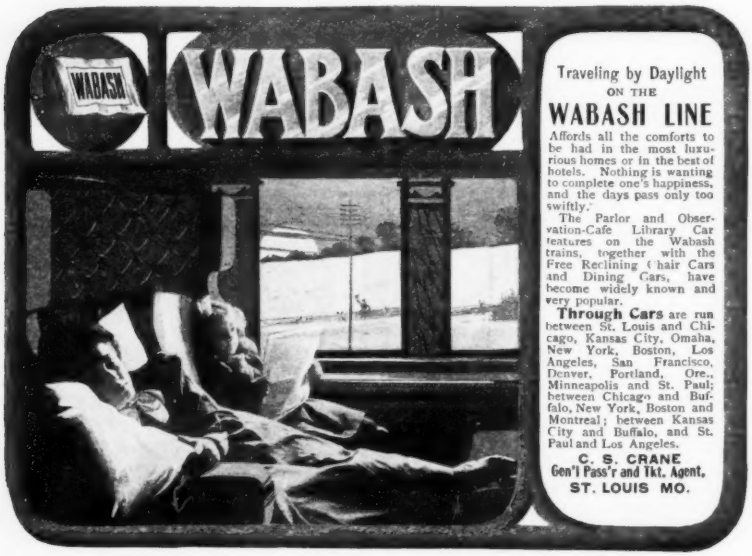

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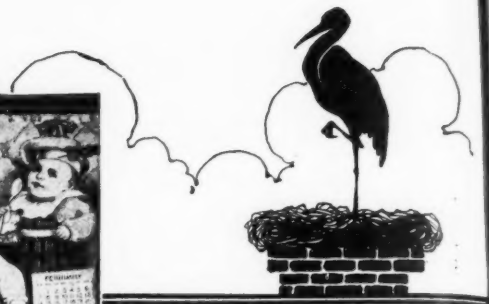

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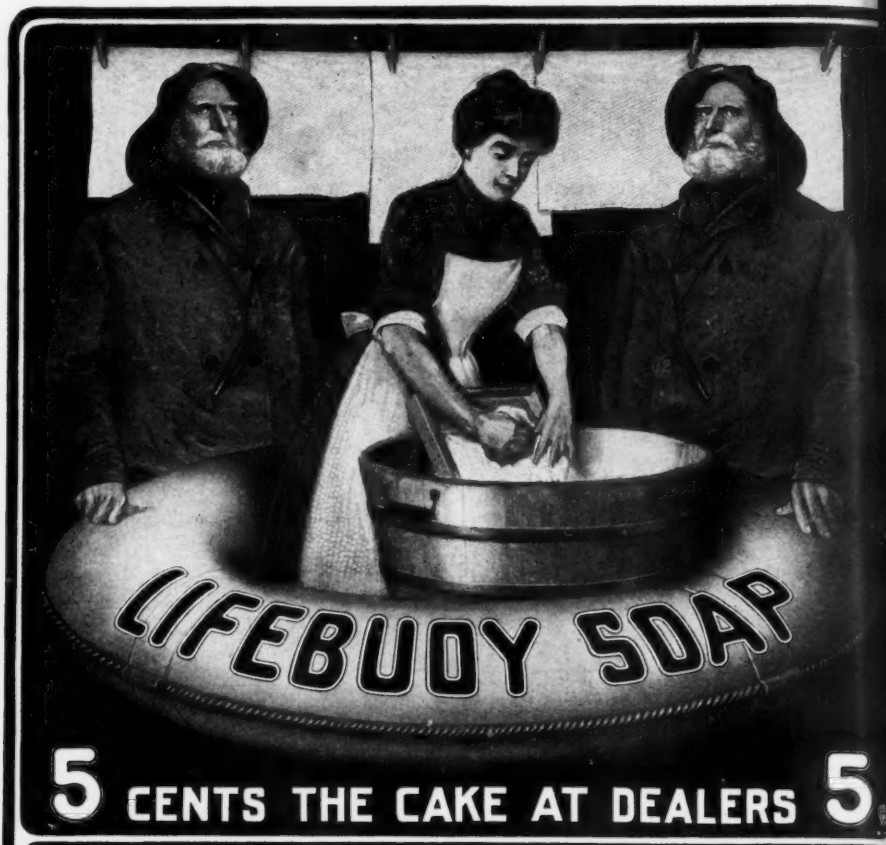

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